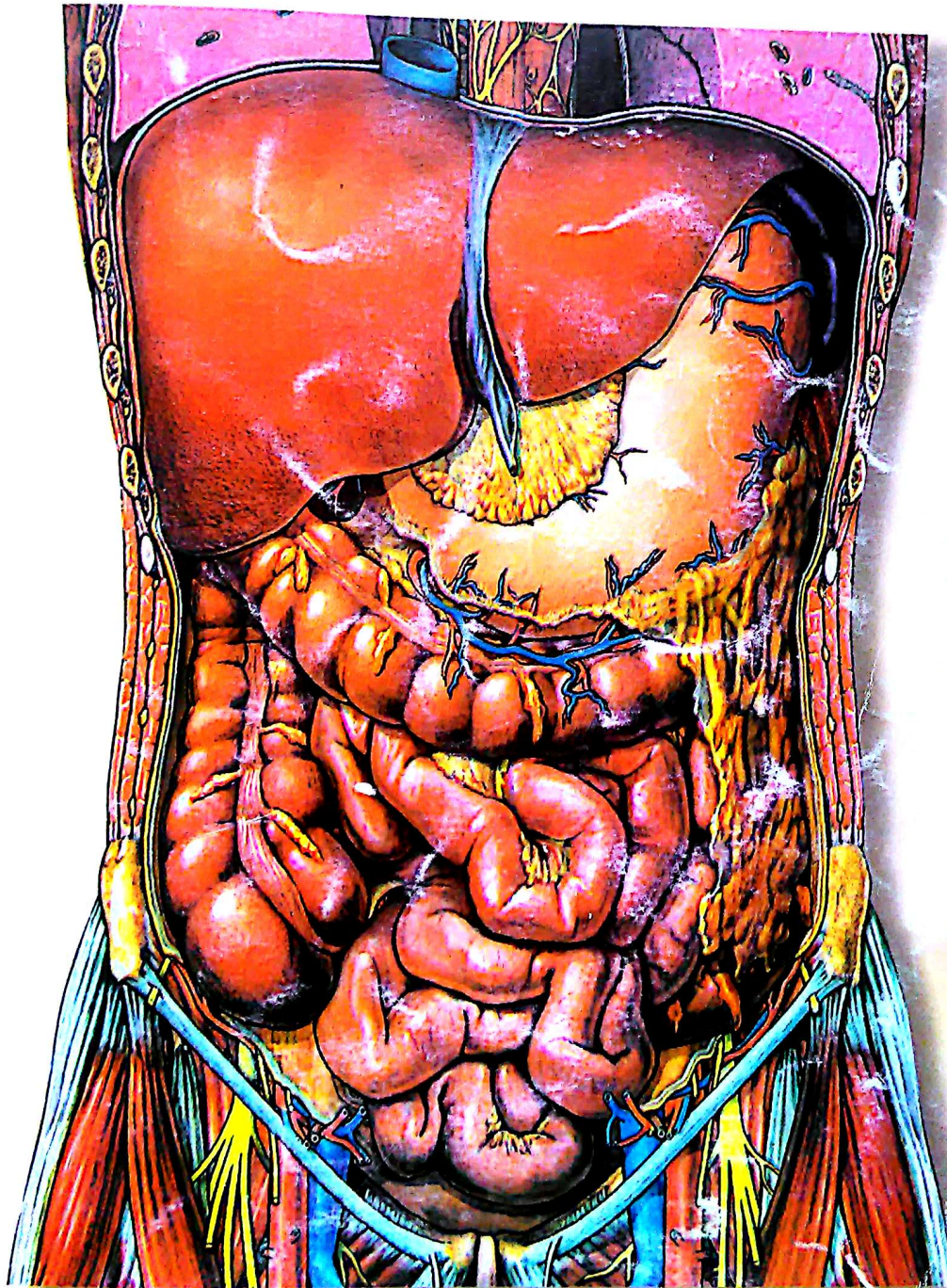
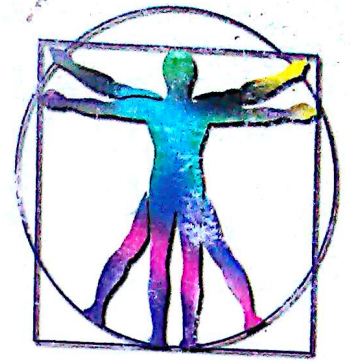


Anatomy of
Abdomen & Pelvis
Summary & Illustrations



Prof. Dr.
Ahmed M. Kamal

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ANTERIOR ABDOMINAL WALL

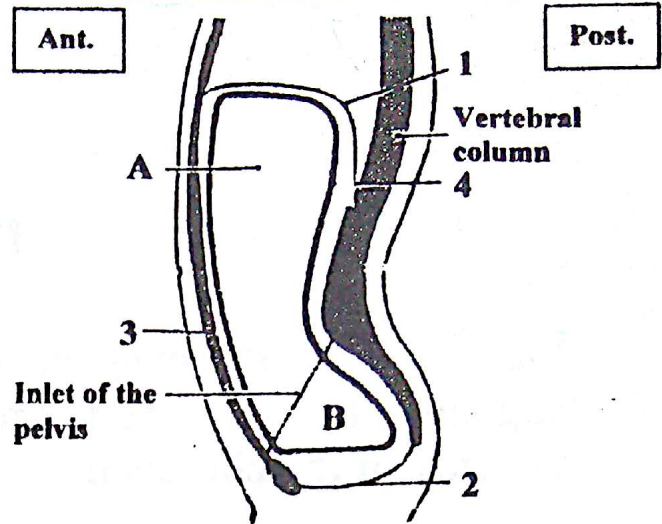
Introduction

The **abdominopelvic cavity** is subdivided into:

- (A) The **abdomen proper** and
- (B) The **pelvis**.

Boundaries of the abdominopelvic cavity:

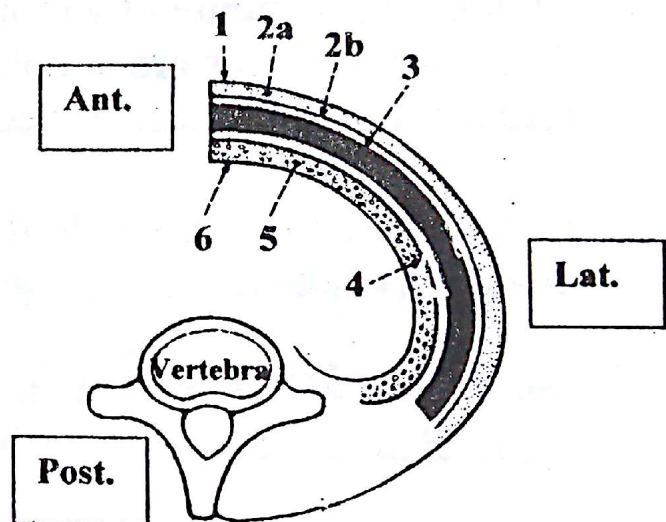
- Superiorly:** the diaphragm(1).
- Inferiorly:** the pelvic diaphragm(2).
- Anteriorly:** the anterior abdominal wall(3).
- Posteriorly:** the posterior abdominal wall(4).
- Laterally:** extension from muscles of the anterior abdominal wall.



Layers of the anterior abdominal wall:

The anterior abdominal wall is formed of the following layers (from superficial to deep):

- (1) **Skin.**
- (2) **Superficial fascia:** which is formed of:
 - (2a) **superficial fatty layer &**
 - (2b) **deep membranous layer.**
- (3) **Muscles.**
- (4) **Transversalis fascia.**
- (5) **Extra-peritoneal tissue.**
- (6) **Parietal layer of the peritoneum.**



Superficial Fascia:

In the lower part of the anterior abdominal wall, the **superficial fascia** is differentiated into two layers:

- 1) **Superficial fatty layer.**
- 2) **Deep membranous layer (scarpa's fascia).**

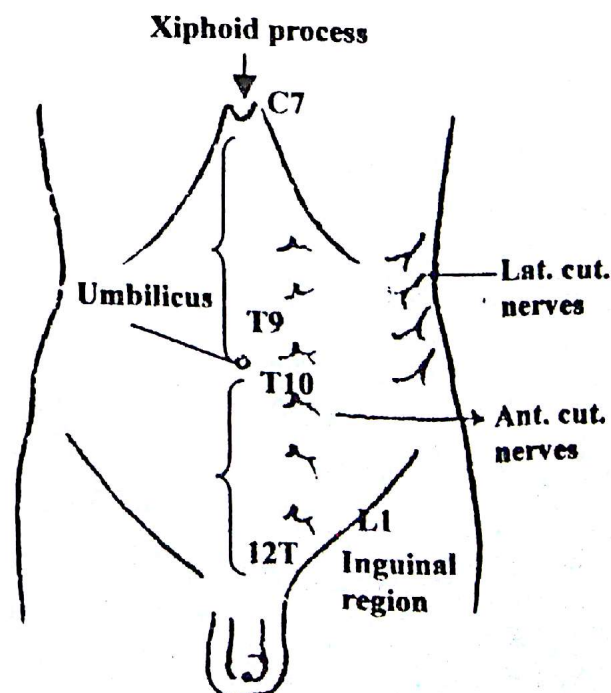
N.B. There is no deep fascia in the anterior abdominal wall, to allow free movements which occur during respiration, after meals, during pregnancy, ... etc.

Cutaneous nerve supply of anterior abdominal wall:

The **skin of the anterior abdominal wall** is supplied segmentally by:

- The lateral and anterior cutaneous branches of
- The lower 5 intercostal nerves (T7-T11),
- The subcostal nerve (T12), ilio-hypogastric and ilio-inguinal nerves (L1) as follows:

1. **3 nerves (T 7,8,9)** supply the skin segmentally from the level of the **xiphoid process** to the **umbilicus**.
2. **T 10** supplied the segment of skin at the level of the **umbilicus**.
3. **3 nerves (T 11, 12 & L 1)** supply the skin segmentally from the level of the **umbilicus** to the **inguinal region**.



Muscles of anterior abdominal wall

These muscles are the following:

1. External oblique.
2. Internal oblique.
3. Transversus abdominis.
4. Cremaster muscle.
5. Rectus abdominis.
6. Pyramidalis.

External Oblique Muscle

Origin: by fleshy 8 digitations from the outer surfaces the lower eight ribs.

- The upper (4) interdigitate with the digitations of the serratus anterior.
- While the lower (4) interdigitate with latissimus dorsi.

Direction of fibers:

- A. Most of the fibers run downwards, forwards & medially, except the upper most and lower fibers.
- B. The upper most fibers run horizontally forwards.
- C. The lower most (posterior) fibers run vertically downwards.

These fibers form the anterior boundary of the inguinal triangle (page 5).

Insertion: by an aponeurosis along a line into:

- (1) the xiphoid process, (2) linea alba,
- (3) pubic crest, (4) pubic tubercle,
- (5) anterior superior iliac spine, and
- (6) the anterior half of the outer lip of the iliac crest.

- Between the pubic tubercle and anterior superior iliac spine, the aponeurosis of the muscle has no bony attachment and is folded backwards upon itself to form the inguinal ligament.

Nerve supply: Lower 6 inter costal nerves.

Inguinal ligament (Poupart's ligament)

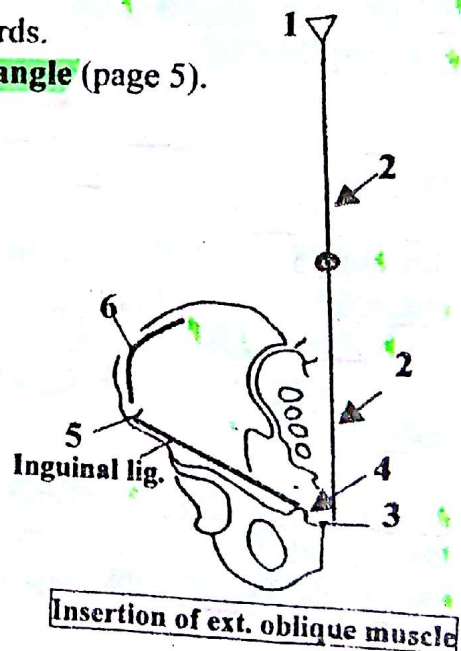
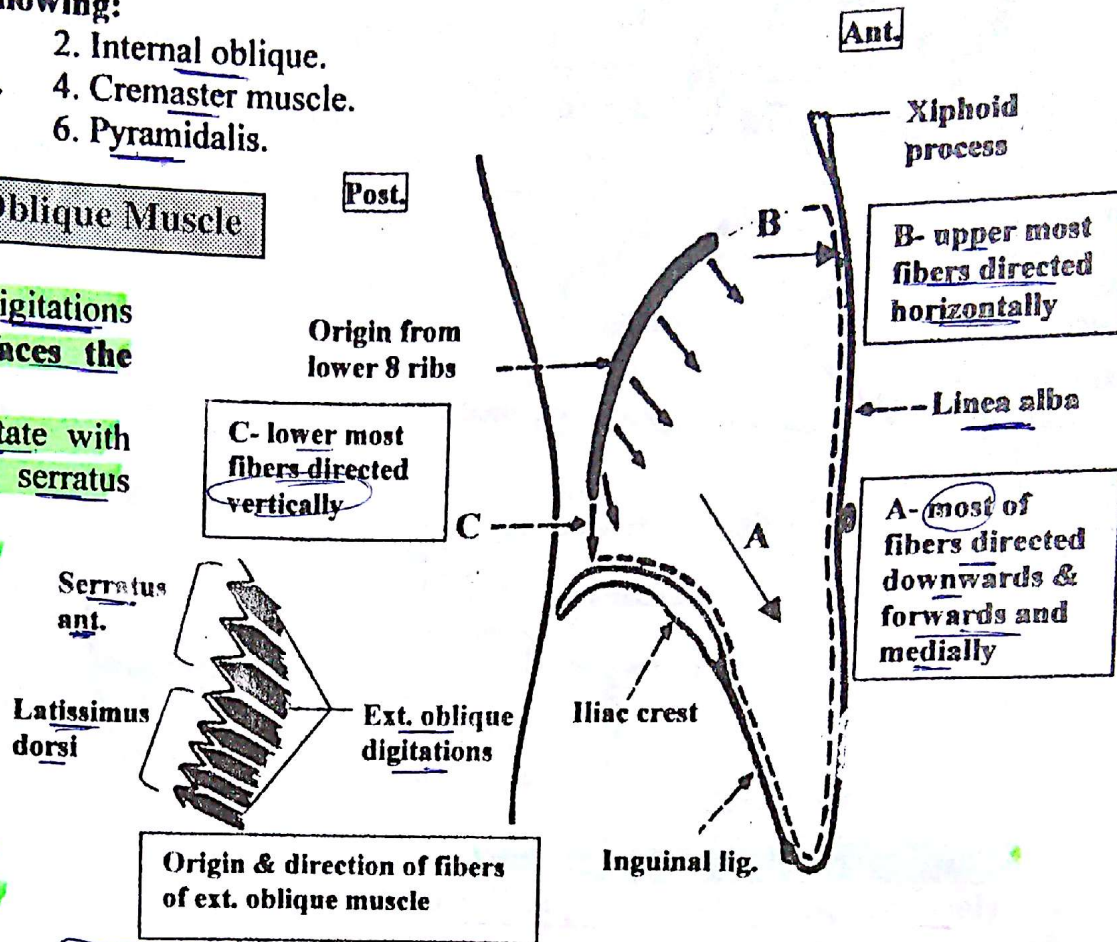
The inguinal ligament is the lower border of the aponeurosis of the external oblique muscle folded backwards upon itself.

Medially, it is attached to the pubic tubercle.

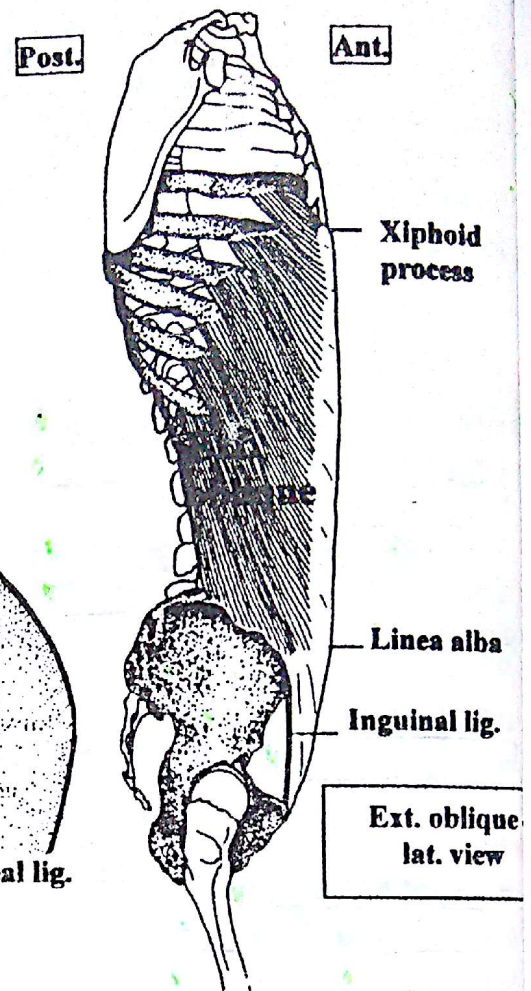
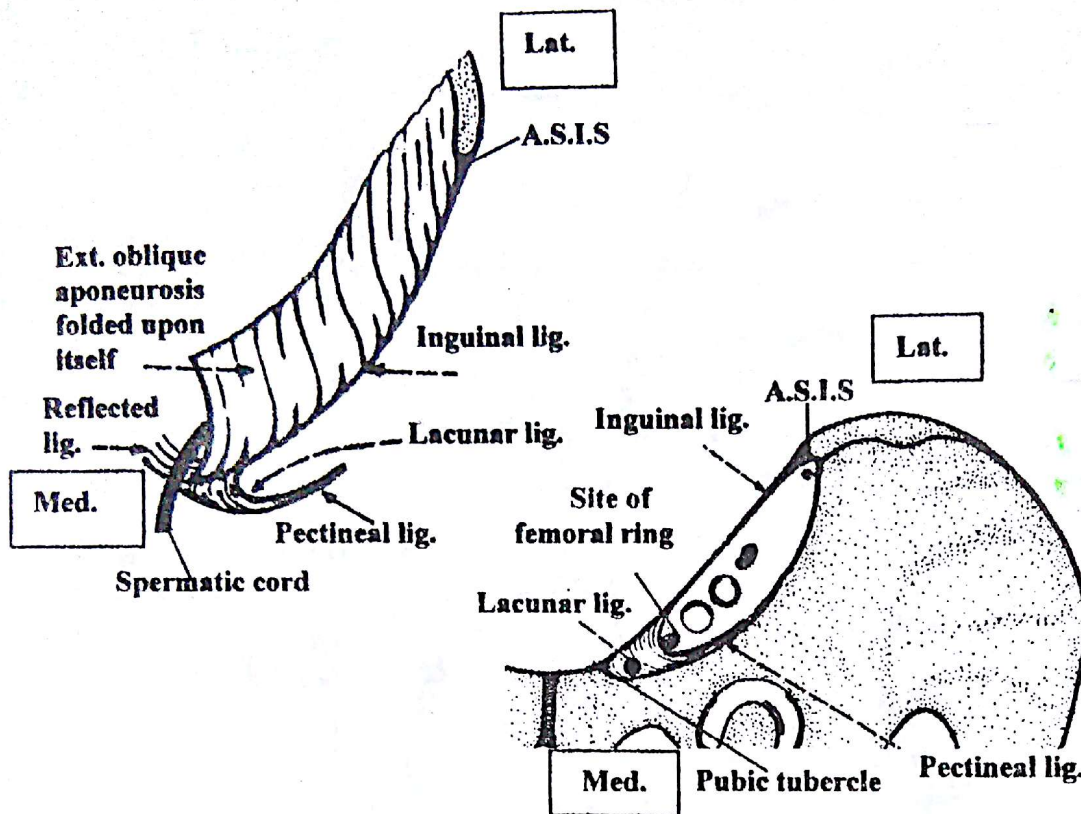
Laterally, it is attached to the anterior superior iliac spine (A.S.I.S).

- The ligament is curved with a convexity towards the thigh, due to the traction of the fascia lata upon it.

- The grooved inner aspect of the ligament gives partial origin to fibers of the internal oblique and transversus abdominis muscles.



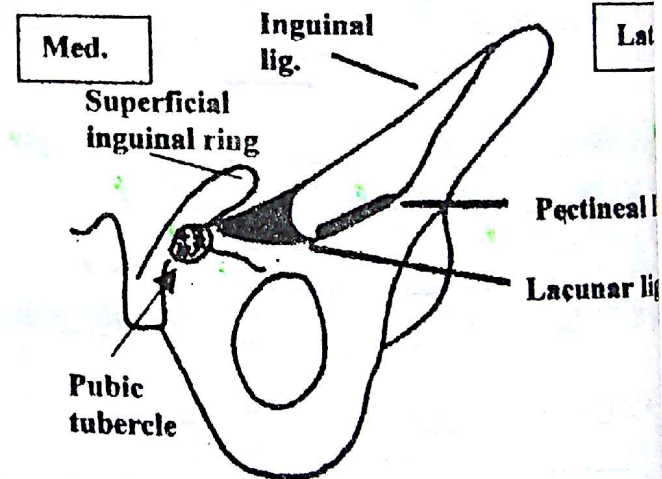
(Inguinal ligament continued)



Other parts of inguinal ligament (lacunar, pectineal & reflected ligaments).

(1) Lacunar ligament (pectineal part of inguinal ligament).

- It is a triangular ligament which occupies the interval between the medial part of the inguinal ligament and pectineal line.
- Its apex is attached to the pubic tubercle.
- Its base is sharp and crescentic and forms the medial boundary of the femoral ring.

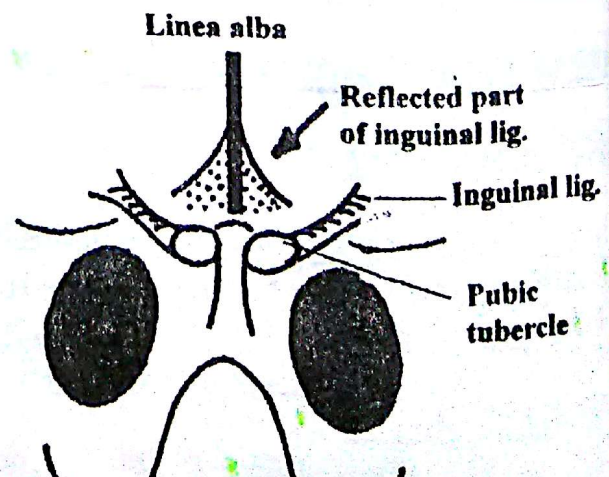


(2) Pectineal ligament (Cooper's ligament):

It is a lateral extension of the lacunar ligament along the superior ramus of the pubis.

(3) Reflected part of the inguinal ligament:

It is a thin band from the medial part of the inguinal ligament which passes upwards and medially to the linea alba.



Superficial inguinal ring:

This is a triangular opening in the aponeurosis of the external oblique just above the pubic tubercle.

Its sides are called crura (a medial and a lateral crus).

Its base is formed by the lateral half of the pubic crest.

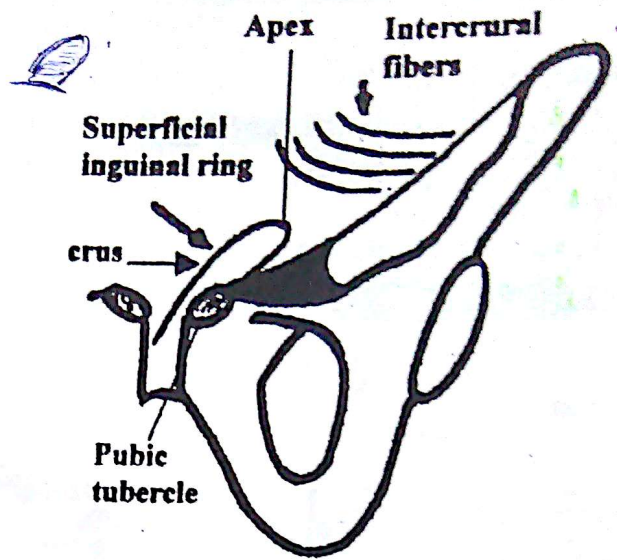
Its apex is directed upwards and laterally; and its center is just above the pubic tubercle.

The crura of the ring are kept from separation by the intercrural fibers.

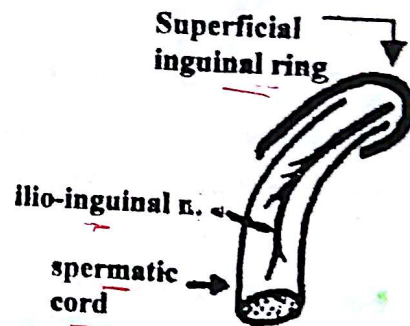
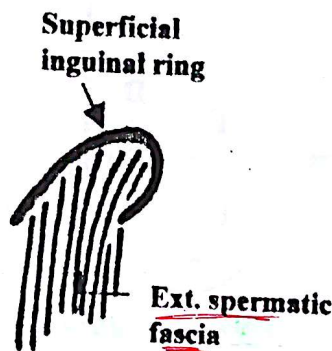
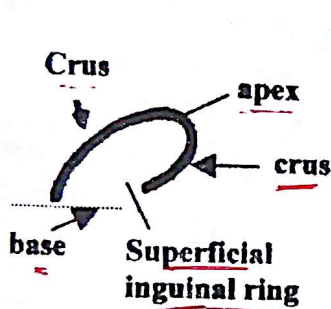
- A fascial prolongation, from the margins of the ring, extends around the cord and testis. This is called the external spermatic fascia.

- The ring gives passage for:

1. The spermatic cord in male or the round ligament of the uterus in female, and
2. The ilio-inguinal nerve.



External covering of round ligament.

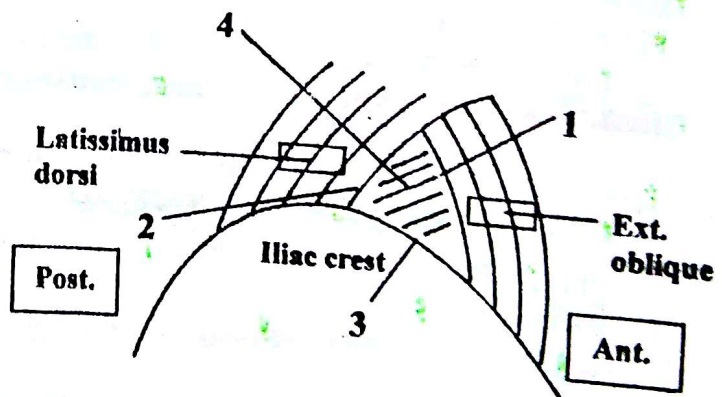


Lumbar triangle:

It is a small triangle situated in the lower part of the back immediately above the middle part of the iliac crest.

It is a rare site for hernia (lumbar hernia).

- Anterior boundary of the triangle is formed by:
(1) The free posterior border of the external oblique.
- Posterior boundary of the triangle is formed by:
(2) The free lateral border of latissimus dorsi.
- Base of the triangle is formed by:
(3) Middle part of the iliac crest.
- (4) Floor of the triangle is formed by the internal oblique muscle.



Internal oblique muscle

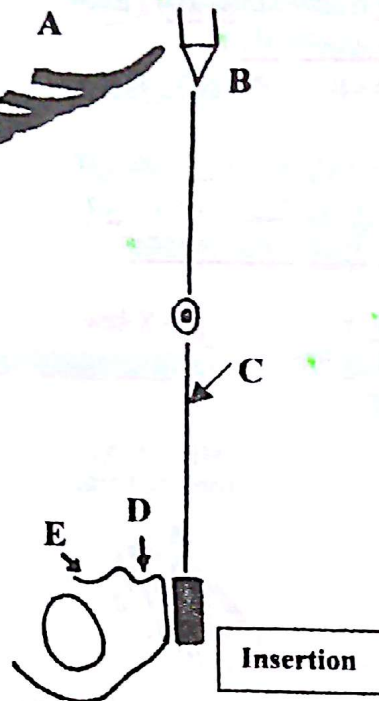
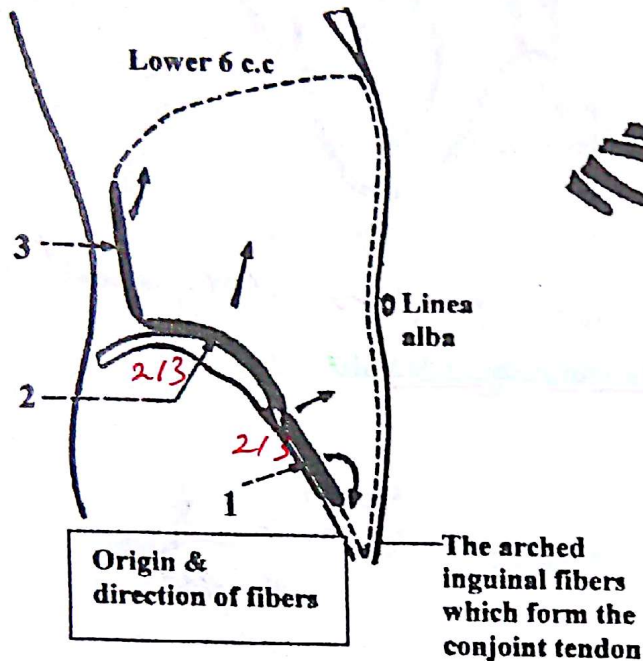
Origin: along a line from:

- (1) lateral two-thirds of the inguinal ligament,
- (2) anterior two-thirds of the intermediate line of the iliac crest and
- (3) lumbar fascia. (It is thick deep fascia which encloses the muscles of the back).

(Internal oblique muscle continued)

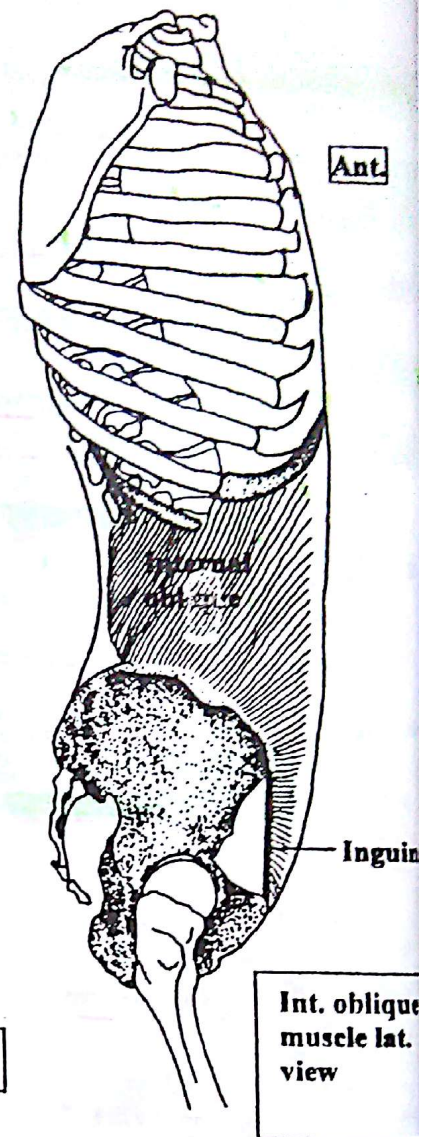
Insertion: into the:

- (A) lower six costal cartilages,
- (B) xiphoid process,
- (C) linea alba,
- (D) pubic crest and
- (E) pectineal line.



Post.

Ant.



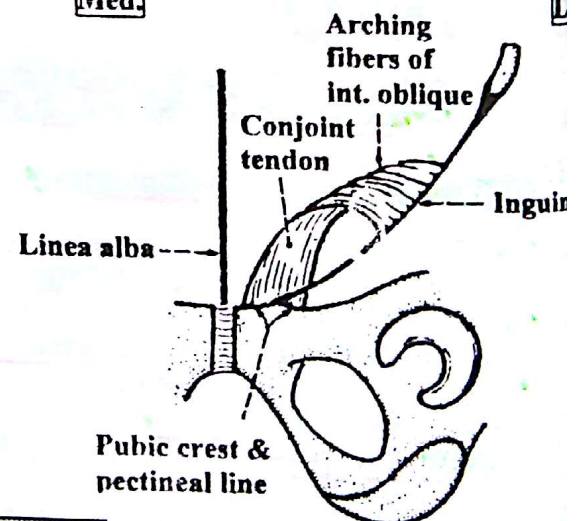
The lower fibers of the muscle form an arch above the spermatic cord to be inserted into the pubic crest and pectineal line.

These fibers are fused with the fibers of the transversus abdominis to form the conjoint tendon.

Direction of fibers: Most of the fibers pass upwards, forwards and medially, except the lower most fibers which arise from the inguinal ligament. These fibers form an arch downwards & medially to join the conjoint tendon.

Nerve supply: The lower 6 intercostal nerves & first lumbar nerves.

Med.



Transversus abdominis muscle

Origin: Along a line from:

- (1) lateral one-third of the inguinal ligament,
- (2) anterior two-thirds of the inner lip of the iliac crest,
- (3) lumbar fascia and
- (4) the inner surface of the lower six costal cartilages, by fleshy slips which interdigitate with the slips of the costal origin of the diaphragm.

(Transversus abdominis continued)

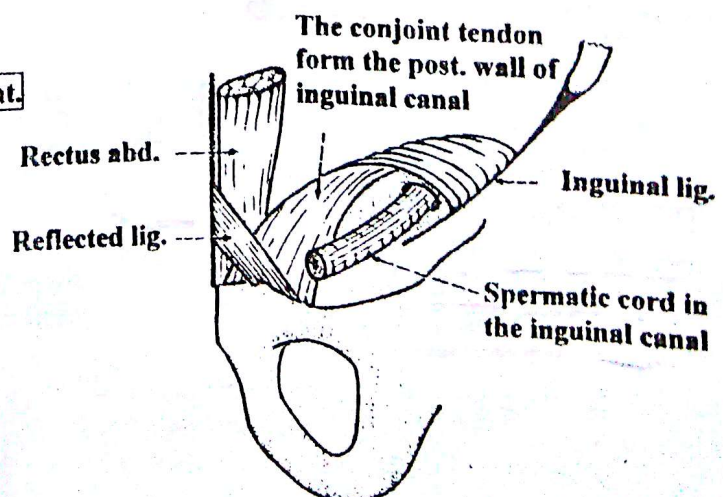
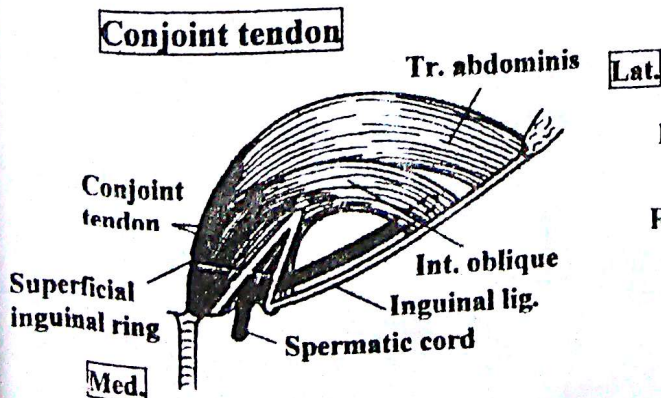
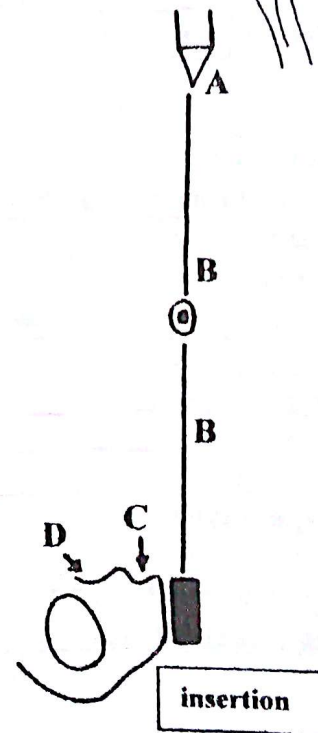
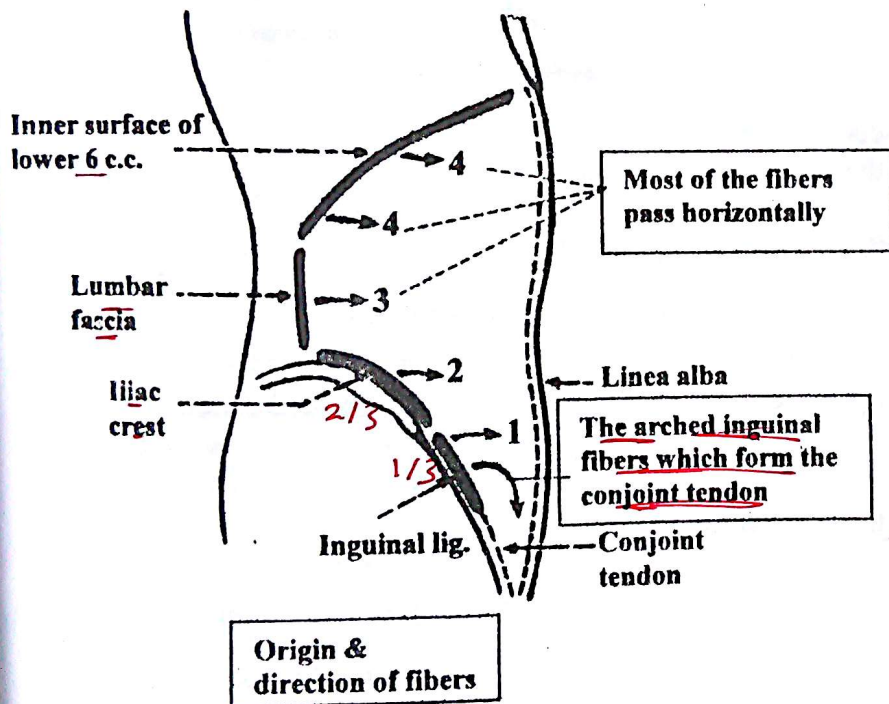
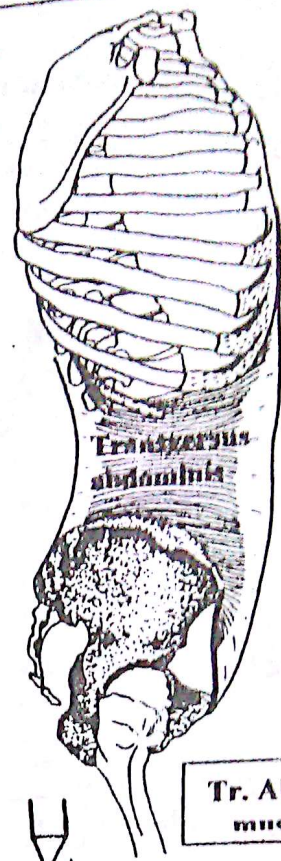
Insertion: into the:

- (A) xiphoid process,
- (B) linea alba,
- (C) pubic crest and
- (D) pectineal line.

- The lower fibers of the muscle form an arch from the origin to the insertion.
- This arch is higher than that of the internal oblique.
- These lower fibers, form the conjoint tendon with the fibers of the internal oblique.

Direction fibers: Most of fibers pass horizontally except the lower most (inguinal) fibers which run downwards & medially to join the conjoint tendon.

Nerve supply: Lower 6 intercostal & first lumbar nerves



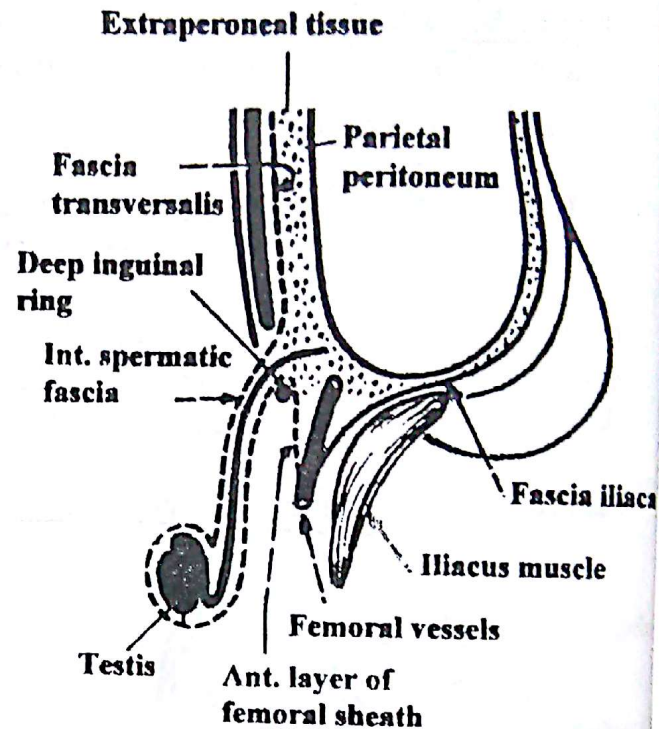
- The conjoint tendon is the fused lower parts of the aponeurosis of the internal oblique and transversus abdominis.
- It is inserted into the pubic crest and pectineal line.
- The conjoint tendon is the most important part of the posterior wall of the inguinal canal.

Fascia Transversalis

- This is a thin fascia which lines the inner surface of the transversus abdominis.
- It is separated from the parietal peritoneum by a layer of extraperitoneal tissue.

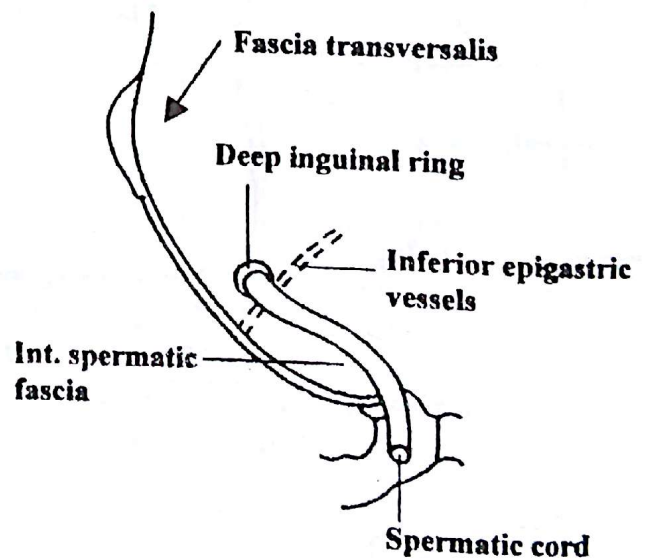
N.B.:

- (1) The fascia transversalis descends in front of the femoral vessels to form the anterior layer of the femoral sheath.
- (2) At the deep inguinal ring, the fascia transversalis extends into the inguinal canal forming a sheath for the spermatic cord and testis called the internal spermatic fascia.



Deep inguinal ring

- This is a small opening in the fascia transversalis just lateral to the inferior epigastric vessels.
- It lies about half an inch above the mid inguinal point.
- A fascial prolongation extends from the margins of the ring around the cord and testis. This is called the internal spermatic fascia.
- The ring gives passage for: The spermatic cord in male or the round ligament of the uterus in female.



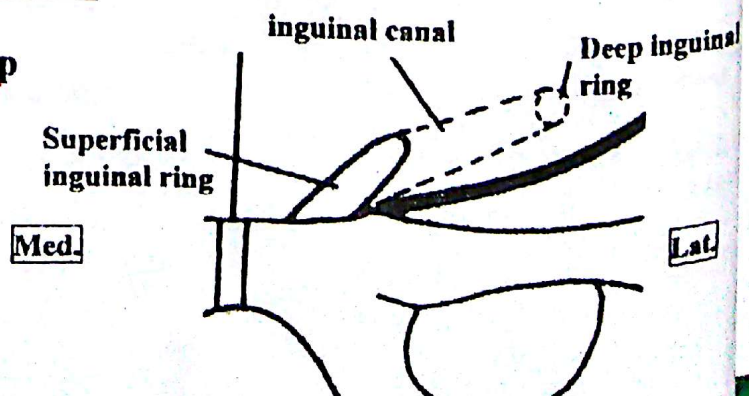
Extraperitoneal fatty tissue

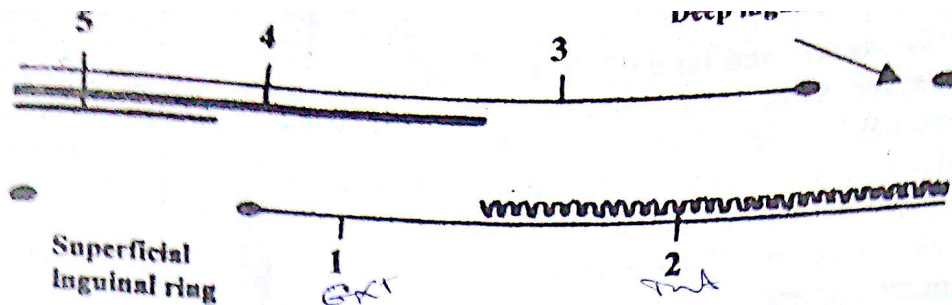
This is a layer of areolar fatty tissue of variable thickness, which lies between the fascia transversalis and the parietal peritoneum.



Inguinal canal

- This is the passage between the deep and the superficial inguinal rings.
- It is well developed in males.
- It is about one half inches long.





The boundaries of the canal are:

A. Anterior wall: which is formed by:

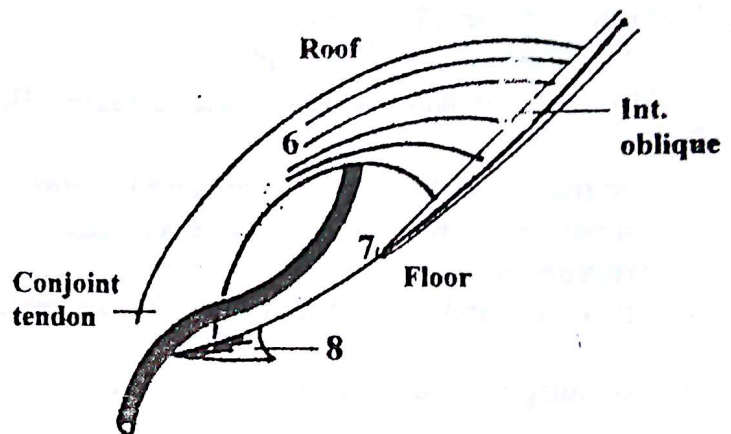
- External oblique muscle(1) along the whole length of the canal.
- Fleshy fibers of the internal oblique(2) along the lateral half of the canal.

B. Posterior wall which is formed by:

- Fascia transversalis(3) along the whole length of the canal.
- Conjoint tendon(4) along the medial half of the canal.
- Reflected ligament(5) along the medial fourth of the canal.

C. Roof: which is formed by the arching lower fibers of the internal oblique(6) which form the conjoint tendon.

The transversus abdominis does not share in the roof because its lower fibers arch higher up than the fibers of the internal oblique.



D. Floor: which is formed by:

- Inguinal ligament(7) laterally.
- Inguinal and lacunar ligaments(8) medially.

Structures passing through the canal:

- In male: the spermatic cord & its coverings + the ilio-inguinal nerve.
- In female: the round ligament of the uterus + the ilio-inguinal nerve.

N.B.: the ilio-inguinal nerve pierces the posterior wall of the canal then passes out through the superficial inguinal ring.

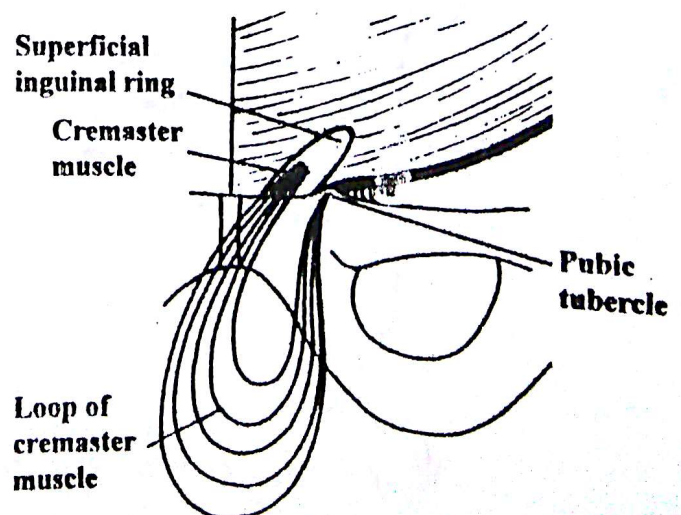
Cremaster muscle

This muscle arises as loops within the inguinal canal **from the internal oblique**.

These loops are connected together by fascia, thus forming a layer **around the cord and testis**.

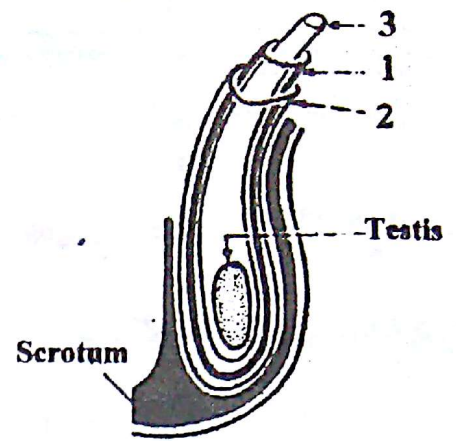
This layer known as the **cremaster muscle and fascia**.

The loops of cremaster muscle and fascia unite in a slender tendon which is **inserted into the pubic tubercle**.



The cremaster muscle and fascia(1) lies between the external(2) and internal spermatic fasciae(3).

- The cremaster muscle is supplied by the genital branch of the genitofemoral nerve and the cremasteric branch of the inferior epigastric artery.



N.B.: In females:

1. The inguinal canal is ill-developed.
2. There is no internal spermatic fascia.
3. The cremaster muscle and fascia is ill-developed.

Rectus abdominis

Origin: from:

- The pubic crest(A) &
- Symphysis pubis(B).

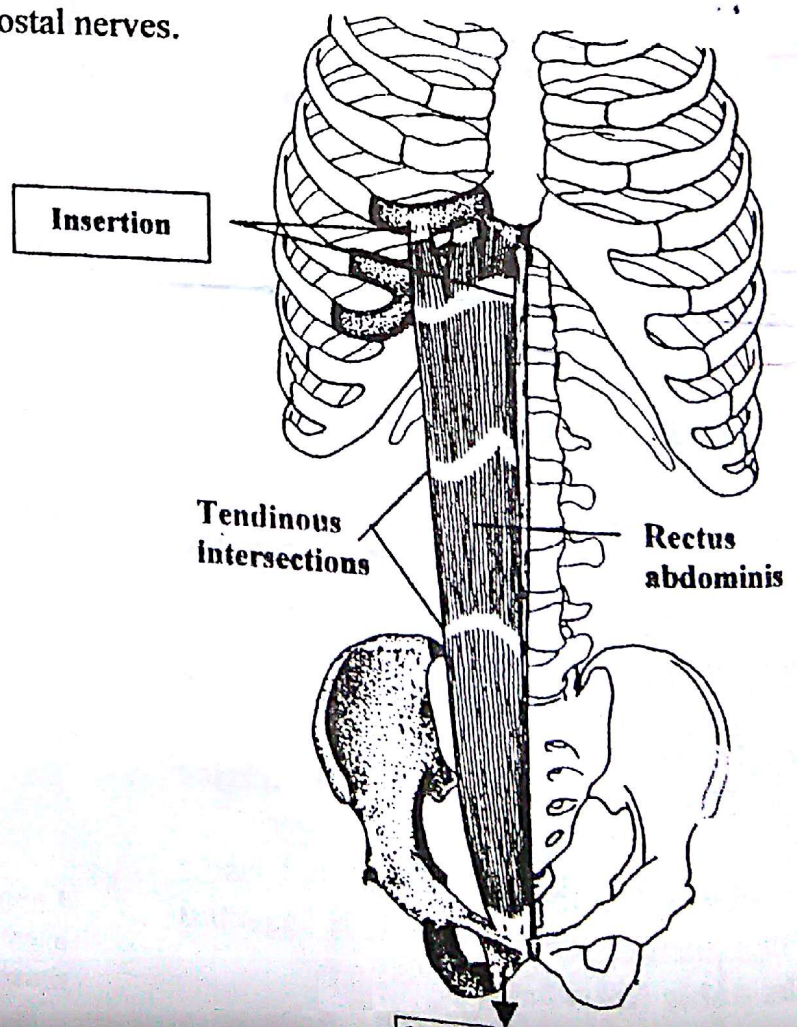
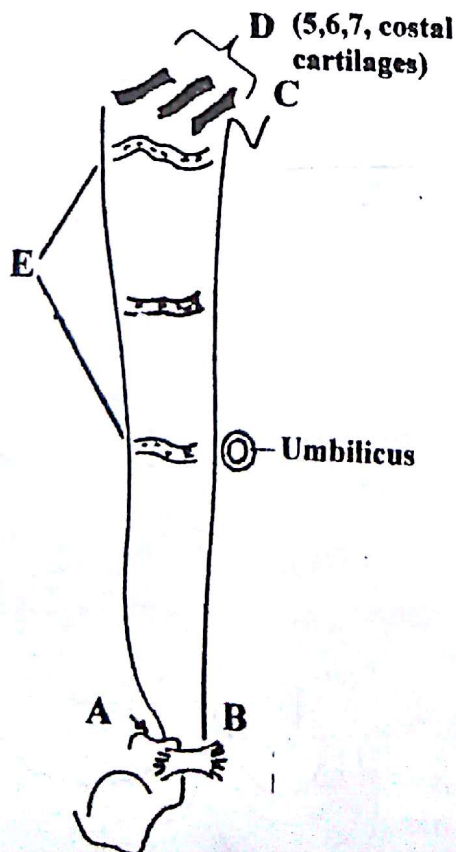
Insertion: along a line into:

- The xiphoid process(C) and
- The fifth, six and seventh costal cartilages(D).

N.B.:

- The muscle is divided into segments by tendinous intersections(E).
- These intersections signify that this muscle is developed from several myotomes.
- The rectus abdominis is enveloped by the rectus sheath.

Nerve supply: The lower 6 intercostal nerves.

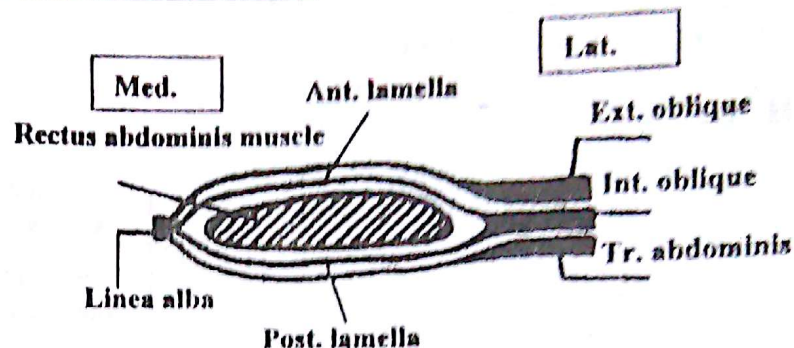


Rectus sheath

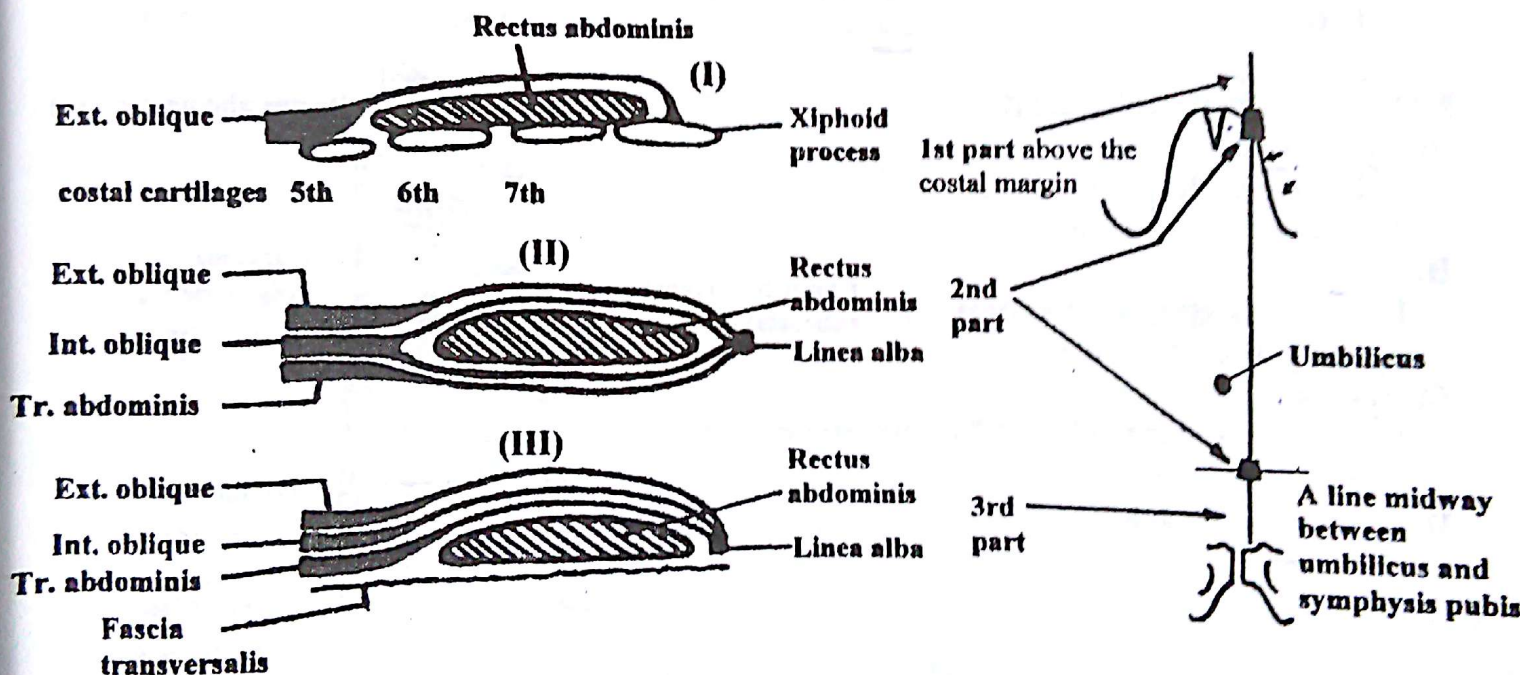
- The aponeurosis of the oblique muscles and transversus abdominis, as they pass towards the lines alba, form an envelope for the rectus muscle.
- This envelope is known as the rectus sheath.
- The part in front of the muscle is called the anterior wall of the rectus sheath, while the part behind the muscle is called the posterior wall of the rectus sheath.

The main event leading to formation of rectus sheath is that:

- The intermediate part of the internal oblique aponeurosis, as it reaches the lateral edge of the rectus muscle, splits into an anterior lamella and a posterior lamella.
- The anterior lamella passes in front of the rectus, while the posterior lamella passes behind the muscle.



N.B.: In the lower part of anterior abdominal wall, the internal oblique aponeurosis passes undivided, together with the transversus aponeurosis, to lie in front rectus muscle.



Part of the rectus sheath: the rectus sheath can be divided into 3 parts:

- First part:** above the level of the costal margin.
- Second part:** extending from costal margin to line $\frac{1}{2}$ way between umbilicus to symphysis pubis.
- Third part:** extending from the previous line above to the symphysis pubis below.

Structure of each part of the sheath:

- 1st part:**
 - Anterior wall is formed by: the external oblique aponeurosis.
 - Posterior wall is formed by: the 5th, 6th & 7th costal cartilage only.

II. 2nd part:

- **Anterior wall formed by:**
 1. Anterior lamella of internal oblique.
 2. External oblique aponeurosis.
- **Posterior wall formed by:**
 1. Transversus aponeurosis.
 2. Posterior lamella of internal oblique muscle.

(I) The 5th, 6th & 7th costal cartilage
Ext. obliqu aponeurosi

(II) Transversus aponeurosi
Post. lamella of int. oblique m
Ant. lamella of int. oblique
Ext. oblique aponeurosis

III. 3rd part:

- **Anterior wall:** formed by the aponeurosis of the 3 muscles (external oblique, internal oblique & transversus abdominis which all pass in front of the rectus muscle).
- **Posterior wall:** is formed only by fascia transversalis.

(III) Formed by fasci transversalis
Aponeurosis of the 3 muscles

N.B.: The aponeurotic posterior wall of the rectus sheath ends at the line $\frac{1}{2}$ way between umbilicus & symphysis pubis by forming an arched border called **arcuate line**.

Contents of the rectus sheath:

A. 2 muscles:

1. Rectus abdominis muscle.
2. Pyramidalis muscle.

B. 2 vessels:

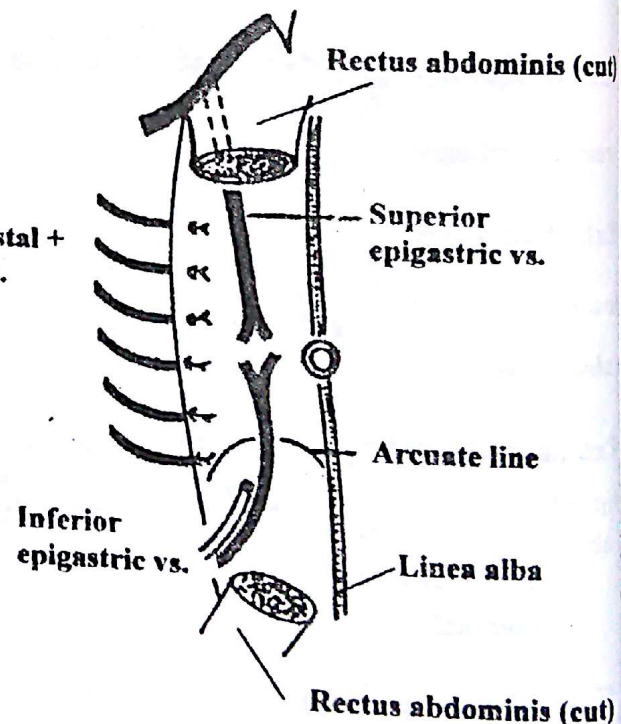
1. Superior epigastric vessels.
2. Inferior epigastric vessels.

C. Nerves:

1. Terminal parts of lower 5 intercostal nerves.
2. Subcostal nerve.

D. Lymphatic vessels.

Lower 5 intercostal + subcostal nerves.



Pyramidalis muscle:

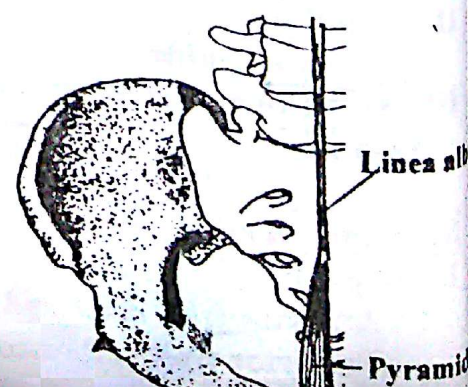
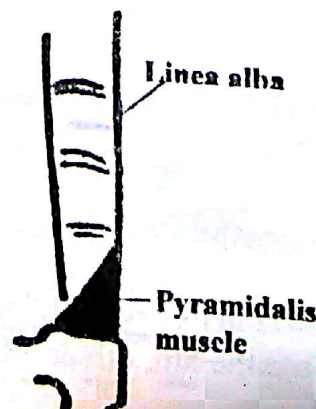
- This is small triangular muscle which lies in front of the lower part of the rectus abdominis.
- It may be absent on one or both sides.

Origin: pubic crest.

Insertion: into the lower part of the linea alba.

Nerve supply: subcostal nerve T12.

Action: stretching the linea alba.



Action of the muscles of the anterior abdominal wall:

1. They are muscles of expiration.
2. Their tone helps in keeping the viscera in position.
3. They help in raising the intra-abdominal pressure e.g. during defecation, maturation, parturition and cough.
4. The rectus abdominis helps in flexion of the trunk.
5. By reflex contraction, they protect the viscera from external shocks directed to the anterior abdominal wall.

The linea alba:

Definition: It is a strong tendinous raphe in the middle line of anterior abdominal wall (between the 2 recti). It is formed by the interlacing fibers of the aponeurosis of the oblique & transversus muscles of both sides.

Attachments:

Above: attached to xiphoid process.

Below: attached to symphysis pubis.

Characters:

1. It shows the umbilical scar in its middle.
2. Below the umbilicus it is narrow.
3. Above the umbilicus it is wide (1 ½ cm).
4. It is a bloodless line.

Summary for muscles of the anterior abdominal wall

Name of Muscle	Origin	Insertion	Nerve Supply	Action
External oblique	Lower eight ribs	Xiphoid process, linea alba, pubic crest, pubic tubercle, iliac crest	Lower six thoracic nerves and iliohypogastric and ilioinguinal nerves (L1)	Supports abdominal contents, compresses abdominal contents; assists in flexing and rotation of trunk. Assists in forced expiration, micturition, defecation, parturition, and vomiting
Internal oblique	Lat. 2/3 of inguinal lig., lumbar fascia, iliac crest	Lower three ribs and costal cartilages, xiphoid process, linea alba, symphysis pubis	Lower six thoracic nerves, iliohypogastric and ilioinguinal nerves (L1)	As above
Transversus	Lat. 1/3 of inguinal lig., lumbar fascia, iliac crest & lower 6 costal cartilages.	Xiphoid process, linea alba, symphysis pubis	Lower six thoracic nerves, iliohypogastric and ilioinguinal nerves (L1)	Compresses abdominal contents
Rectus abdominis	Symphysis pubis and pubic crest	Fifth, sixth, and seventh costal cartilages and xiphoid process	Lower six thoracic nerves	Compresses abdominal contents and flexes vertebral column; accessory muscle of expiration
Pyramidalis (if present)	Anterior surface of pubis	Linea alba	Twelfth thoracic nerve	Tenses the linea alba

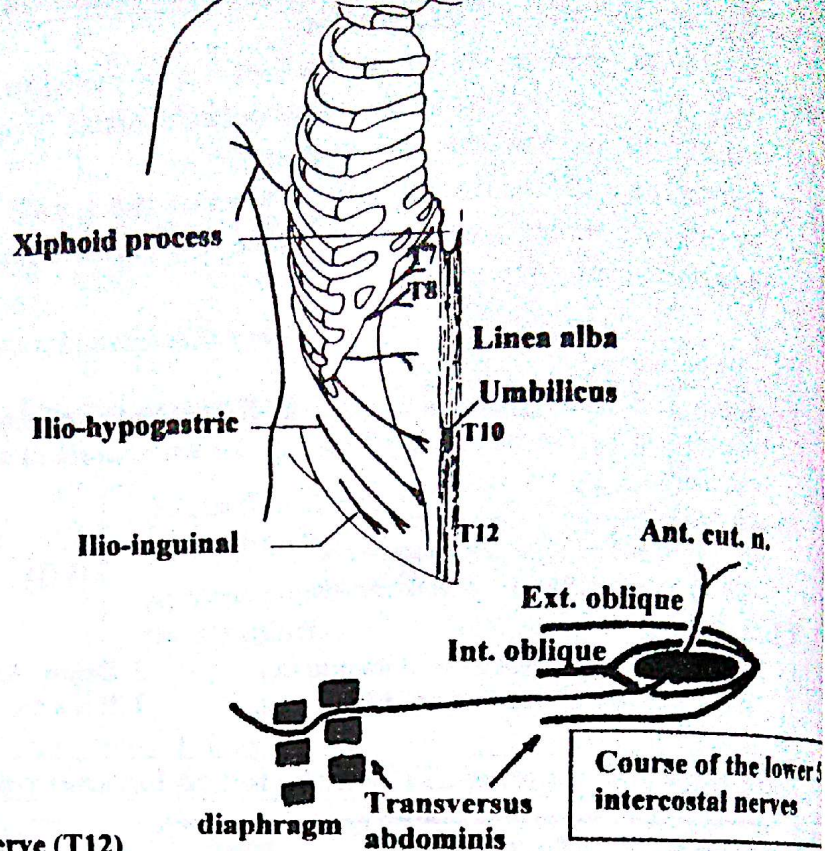
Nerve supply of the anterior abdominal wall

The anterior abdominal wall is supplied, in a segmental manner, by:

1. the lower five intercostal nerves (T7 – T11),
2. subcostal nerve (T12),
3. ilio-hypogastric and ilio-inguinal nerves (L1), arranged from above downwards.

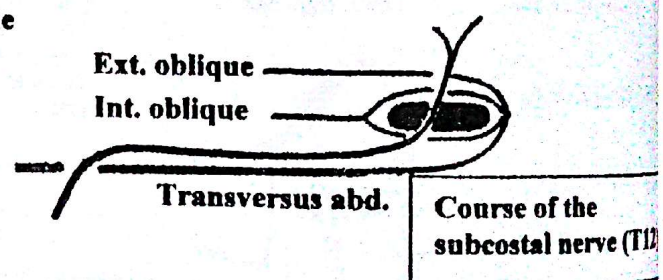
Lower five intercostal nerves:

- They leave the costal grooves and enter the anterior abdominal wall by passing between digitations of diaphragm & transversus abdominis muscle.
- They run anteromedially between the internal oblique & transversus abdominis muscles.
- During this course it supplies the transversus abdominis and the oblique muscles.
- At the lateral border of the rectus abdominis muscle, they pierce posterior wall of the rectus sheath then the rectus muscle & supplies it and finally it pierces the anterior wall of the sheath to end as an anterior cutaneous nerve.



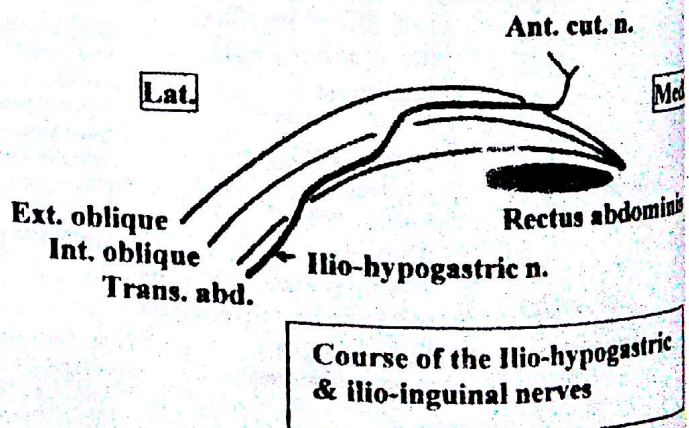
Subcostal nerve (T. 12):

- Is the ventral ramus of the last thoracic nerve (T12).
- It pierces the transversus abdominis and runs, between it and the internal oblique where it supplies the transversus abdominis and oblique muscles.
- Then, it enters the rectus sheath it supplies the rectus and pyramidalis muscles.
- Lastly, it pierces the anterior wall of the rectus sheath and supplies the skin in front of the lower part of the rectus sheath.



Ilio-hypogastric nerve (L. 1):

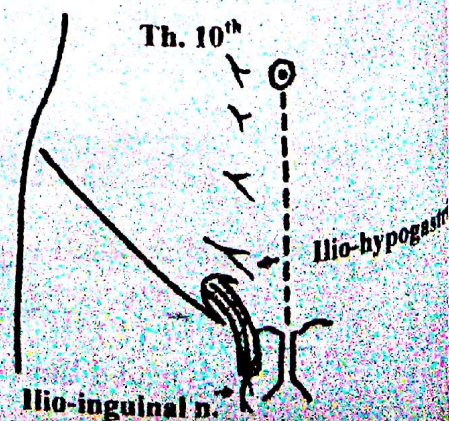
- This is a branch of the lumbar plexus.
- It pierces the transversus abdominis and runs between it and the internal oblique.
- Then, it pierces the internal oblique and runs between it and the external oblique.
- During this course it supplies the transversus and oblique muscles.
- It finally, pierces the external oblique to supply the skin, about two inches above the medial part of the inguinal ligament.



Ilio-inguinal nerve (L. 1):

- This is a branch of the lumbar plexus.
- It follows the same course as the ilio-hypogastric nerve, but at a slightly lower level. But, its terminal part does not pierce the external oblique.
- It passes out through the superficial inguinal to supply the skin of the scrotum or labium majus and the skin of the upper part of the medial side of the thigh.

N.B.: Always remember that the ilio-hypogastric and ilio-inguinal nerves do not enter into the rectus sheath.



Arterial Supply of the Anterior Abdominal wall

1. Superior epigastric artery:

Origin: One of the two terminal branches of the internal mammary artery.

Course: It descends between the rectus muscle and the posterior wall of the sheath. About the level of the umbilicus it ends by anastomosing with the inferior epigastric artery.

Branches: supply the upper part of the rectus abdominis and the overlying skin.

2. Musculo-phrenic artery:

Origin: The other terminal branch of the internal mammary artery.

Course: Runs along the costal margin.

Branches: Supply the anterior abdominal and thoracic walls and diaphragm.

3. Inferior epigastric artery:

Origin: from the external iliac artery just above the inguinal ligament.

Course: runs medially below the deep inguinal ring for a very short distance.

- Then, the artery ascends upwards and medially, medial to the deep inguinal ring.
- The artery pierces the fascia transversalis and passes in front of the arcuate line to enter the rectus sheath, where it ascends between the rectus muscle and the posterior wall of the sheath. About the level of the umbilicus it ends by anastomosing with the superior epigastric artery.

Branches:

1. **Pubic branch:** anastomoses with the pubic branch of obturator artery.
2. **Cremasteric artery:** passes through the deep inguinal ring to supply the cremaster muscle.
3. **Muscular branches:** to the lower part of the rectus muscle.

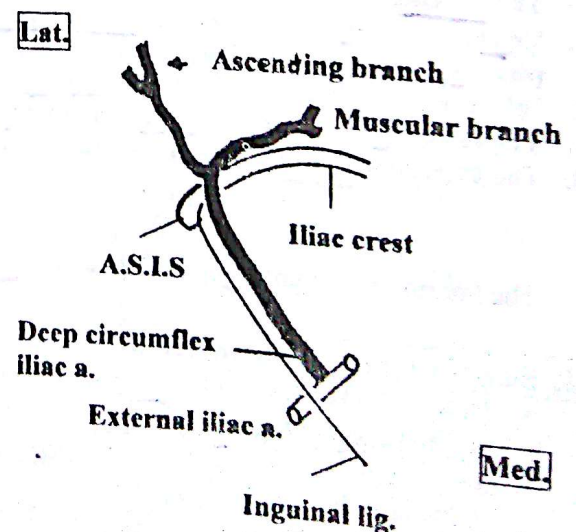
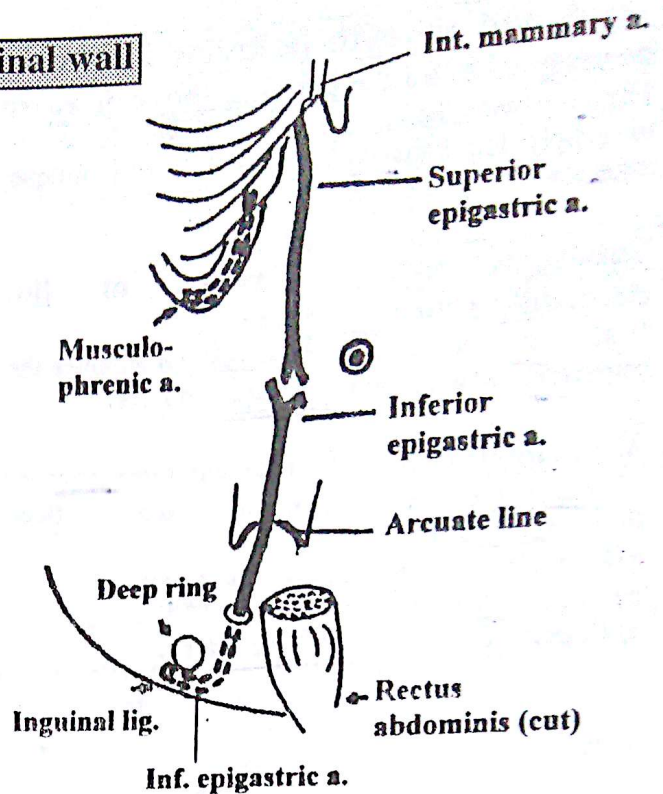
4. Deep circumflex iliac artery:

Origin: from the external iliac artery just above the inguinal ligament.

Course: pierces the fascia transversalis and runs upwards and laterally along the inguinal ligament to the anterior superior iliac spine (A.S.I.S). Then, it runs along the inner lip of the iliac crest where it pierces the transversus abdominis, and ends about the middle of the iliac crest by supplying branches to the transversus and internal oblique muscles.

Branches:

- a. **Ascending branch:** which pierces the transversus abdominis in front of the anterior superior iliac spine and ascends between the transversus abdominis and internal oblique to supply both muscles.
- b. **Muscular branches:** to the transversus abdominis and internal oblique.



5. Tenth and eleventh posterior intercostal arteries:

branches of the descending thoracic aorta.

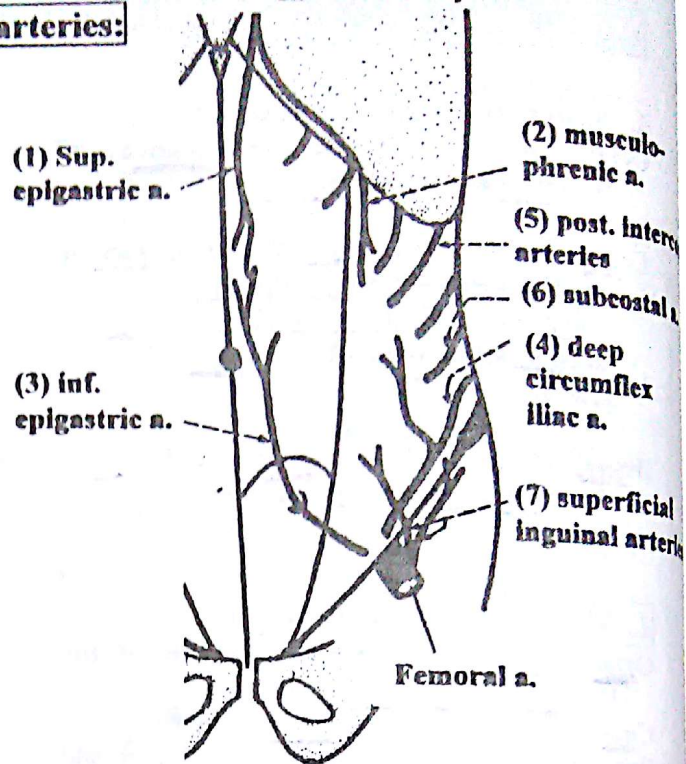
They run with the corresponding intercostal nerves to supply the transversus abdominis and oblique muscles.

6. Subcostal artery: branch of the descending thoracic aorta.

It accompanies the subcostal nerve and supplies the transversus abdominis and oblique muscles.

7. Superficial inguinal arteries: three branches of femoral artery which ramify in the superficial fascia of the groin:

- Superficial external pudendal artery.
- Superficial epigastric artery.
- Superficial circumflex iliac artery.



Summary for the arteries of the anterior abdominal wall

(1) Superior epigastric	both are the 2 terminal branches of the internal mammary artery.
(2) Musculo phrenic	
(3) Inferior epigastric	both are branches of the external iliac artery.
(4) Deep circumflex iliac	
(5) 10th & 11th posterior intercostal arteries	they are branches of descending thoracic aorta.
(6) Subcostal artery	
(7) 3 superficial inguinal arteries	they are branches of the femoral artery.

Venous drainage of the anterior abdominal wall

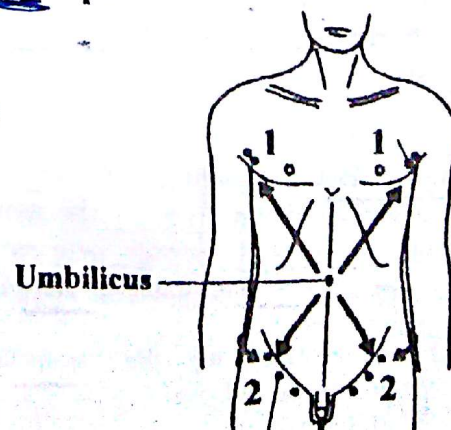
- The anterior abdominal wall is drained by veins corresponding to the arteries.
- These veins are:
 - Venae comitantes of the superior epigastric arteries & venae comitantes of the musculo phrenic artery → both drain into the venae comitantes of the internal thoracic artery.
 - Inferior epigastric vein & deep circumflex iliac vein → both veins drain into external iliac vein.
 - The lower 2 posterior intercostal & subcostal veins → drain into the venae azygos.
 - The superficial inguinal veins → drain into great saphenous vein.

Lymph vessels of anterior and lateral abdominal walls

The lymph vessels are arranged into superficial and deep groups:

1. Superficial lymph vessels:

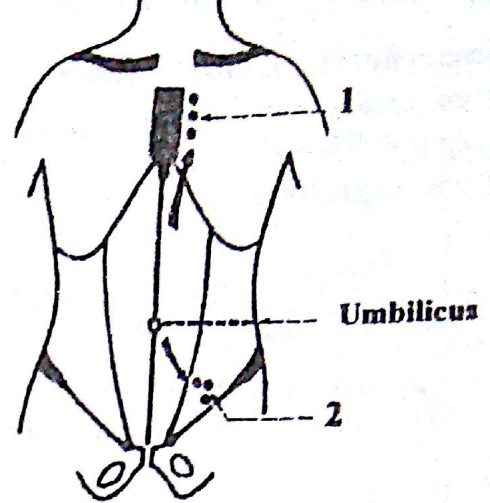
- Above the level of the umbilicus: the lymph vessels end in pectoral (axillary) lymph nodes (1). Some vessels pierce the intercostal spaces to end in internal thoracic lymph nodes.
- Below the level of the umbilicus: the lymph vessels end in the horizontal group of superficial inguinal lymph nodes (2).



2. Deep lymph vessel:

They receive lymph from the muscles and deep structures and join the deep veins.

- Above the level of the umbilicus: the lymph vessels join superior epigastric vein to end in internal thoracic (mammary) lymph nodes (1).
- Below the level of the umbilicus: the lymph vessels end in external iliac lymph nodes (2).

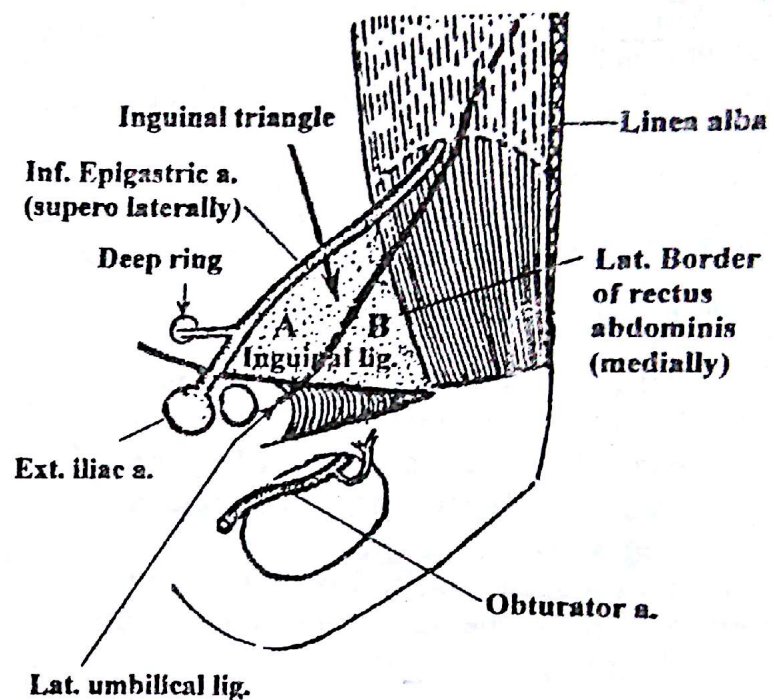


Inguinal triangle (Hasselbach's triangle)

- This is a triangular area on the inner aspect of the lower part of the anterior abdominal wall.
- Medially it is bounded by the lateral border of the rectus abdominis.
- Inferiorly it is bounded by the medial half of the inguinal ligament.
- Supero-laterally it is bounded by the inferior epigastric artery.
- The floor of the triangle is formed by the fascia transversalis.
- The lower part of the floor of the triangle forms the posterior wall of the inguinal canal.

Subdivision: The lateral umbilical ligament (obliterated umbilical artery) runs over the floor of the triangle and divides it into two parts:

- a part lateral to the lateral umbilical ligament and
- a part medial to the ligament.



The lower part of the inner aspect of ant. abdominal wall showing the inguinal triangle

Clinical importance: The inguinal triangle may be site of a hernia called the direct inguinal hernia due to the weakness of the conjoint tendon.

MALE EXTERNAL GENITAL ORGANS

Scrotum

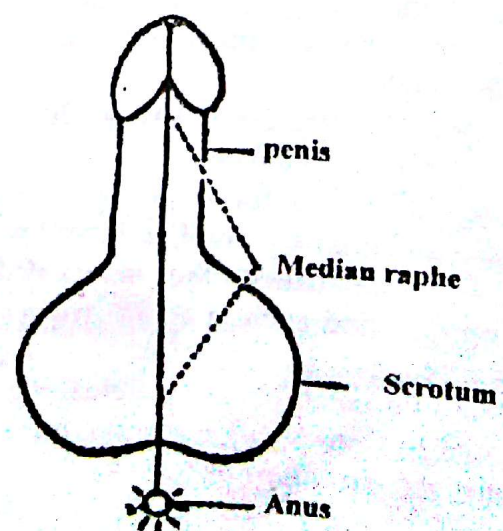
This is a skin fold which is lined by several fascial and muscular strata surrounding the testis.

It is divided into two compartments, one for each testis, by a septum.

This septum is incomplete superiorly.

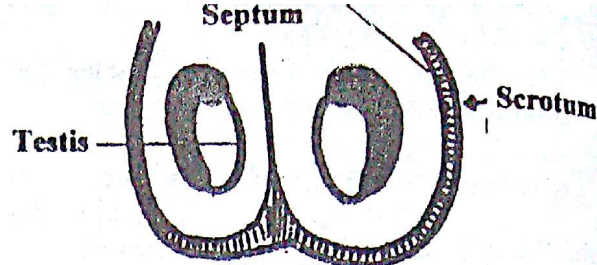
The skin of the scrotum is dark, wrinkled and presents a median raphe.

The superficial fascia is differentiated into two layers:



1. **Superficial layer:** which is formed of involuntary muscle fibers known as the **dartos muscle**. There is no fat in the **scrotum**.

2. **Deep membranous layer.**



Nerve supply of the scrotum:

- The **anterior third** is supplied by **L1** through the **ilio-inguinal nerve** & **genital branch** of the **genitofemoral**.
- The **posterior two third** is supplied by **S3** through the **scrotal branches** of the **perineal nerve** & the **perineal branch** of the **posterior cutaneous nerve** of the thigh.



Blood supply of the scrotum:

- Superficial & deep **external pudendal arteries** (from femoral artery).
- Posterior scrotal branches of **internal pudendal artery** (branch of internal iliac artery).
- Cremasteric artery** (branch of inferior epigastric artery).

Lymphatic drainage:

The lymphatics of the scrotum & penis drain into the **superficial inguinal lymph nodes**.

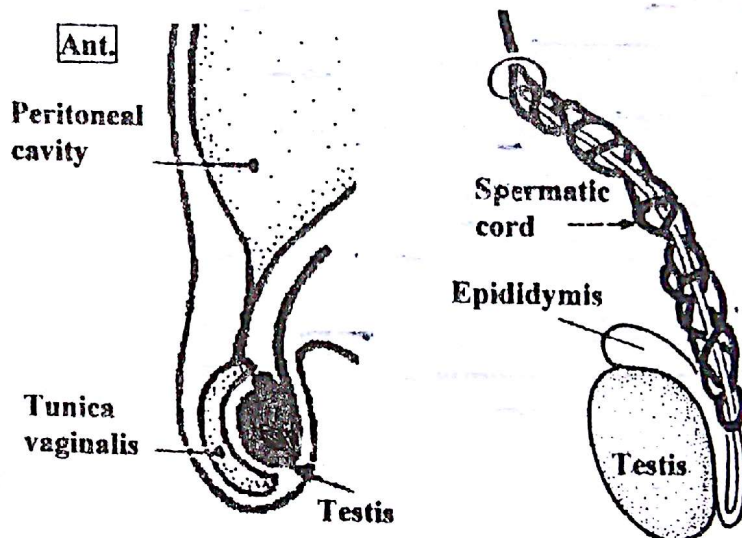
N.B.: Layers of the scrotum = covering of the testis, and will be described later.

Testis

This is the primary sex organ in male.

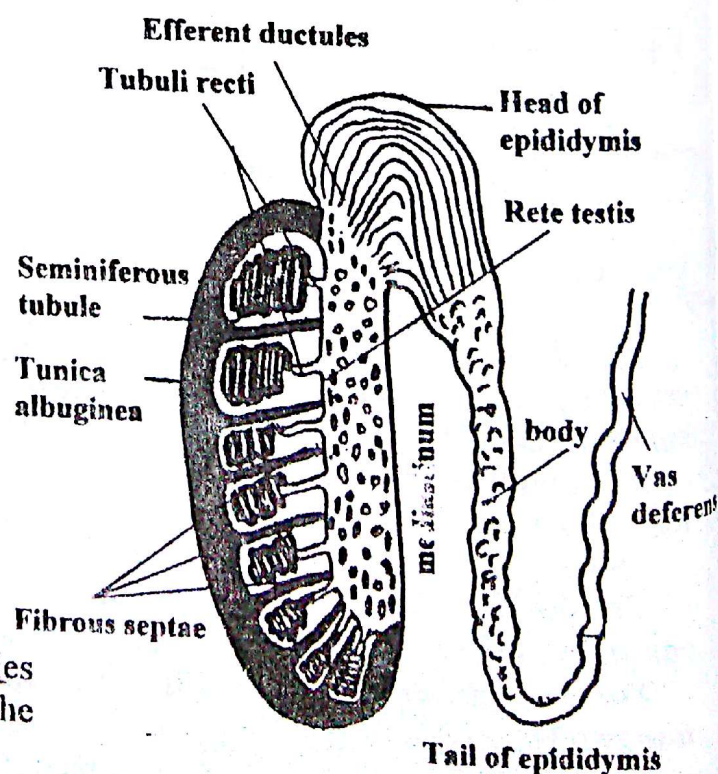
- Its **anterior border**, **medial** and **lateral surfaces** are covered by the **visceral layer of the tunica vaginalis**.
- Its posterior border has no covering of tunica vaginalis and is **directly** related to the **epididymis**.

Each testis is suspended in the **scrotum** by the **spermatic cord**.



Structure of the testis:

- The testis has a thick white glistening capsule called **tunica albuginea**.
- This capsule is thickened along the posterior border of the testis to form the **mediastinum testis**.
- From the mediastinum, **fibrous septa** project into the inner surface of the **tunica albuginea**.
- These **fibrous septae** divide the testis into about **250 lobules**.
- Each **lobule** contains **two (1-3)** thin, long and highly convoluted tubules.
- These are called the **seminiferous tubules**; and each is about **two feet** in length.
- The two **seminiferous tubules** of each **lobules** **unite** to form a **single straight tubule** called the **straight seminiferous tubule**.

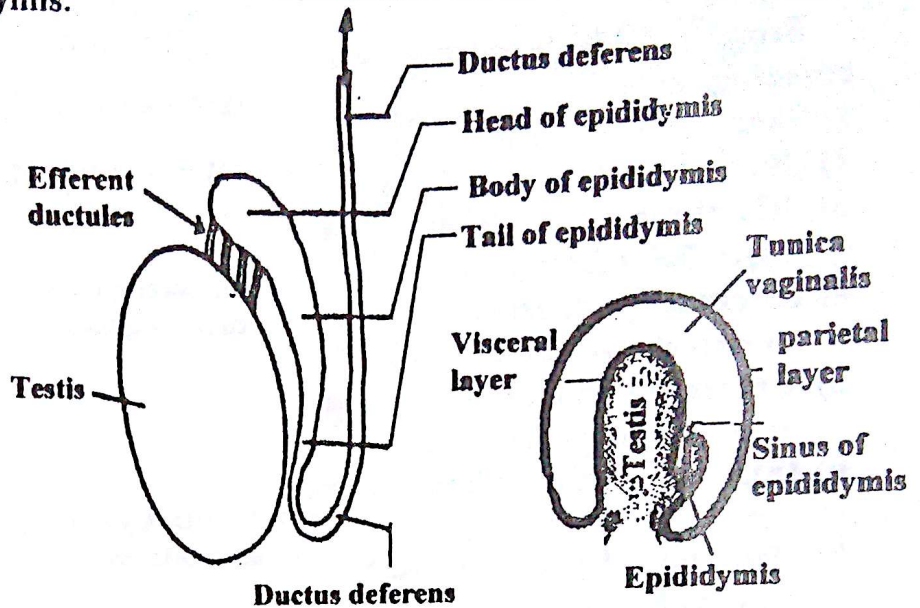


(Structure of the testis continued)

- The straight tubules (**tubuli recti**) of all lobules enter into the mediastinum where they break into a network of canaliculi known as the **rete testis**.
- From the upper part of the rete testis a number (15-20) of **efferent ductules** (**vasa efferentia**) arise and join the epididymis.

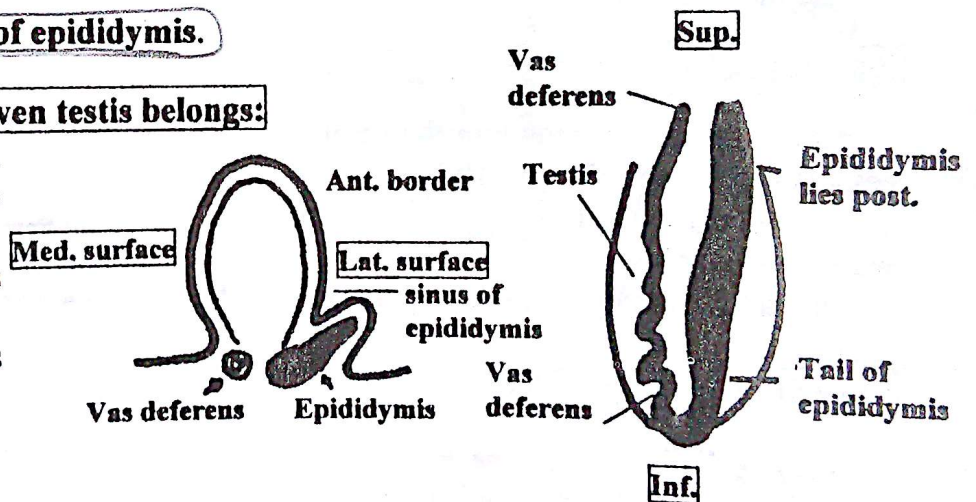
Epididymis

- This is a curved body applied to the **posterior border** of the testis, but nearer to its lateral side.
- Its upper end is larger and is called the **head of epididymis**.
- Its central part is called the **body**.
- Its lower end is tapering and is called the **tail**.
- The **ductus deferens** (**Vas deferens**) arises from the **tail of epididymis** and ascends on the **posterior border of the testis** medial to the epididymis.
- A **recess of tunica vaginalis** intervenes between the testis and the body of epididymis on the lateral side. This recess is called the **sinus of epididymis**.



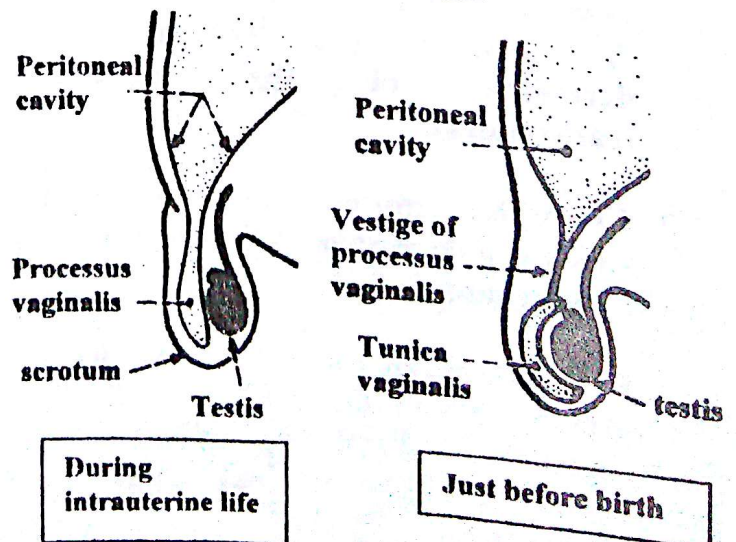
How to know to which side a given testis belongs:

- (1) The **vas deferens** arises from the **tail of epididymis** which is directed **inferiorly**.
- (2) The **epididymis** lies **posterior to the testis**.
- (3) The **sinus of epididymis** is situated **laterally**.



Tunica vaginalis

- This is a **serous sac** which **covers the testis** in the scrotum.
- It represents the **unobliterated part** or the **processus vaginalis**, which is a tubular prolongation of the peritoneal cavity which enters the scrotum during intrauterine life.
- The part of the processus within the canal becomes **obliterated just before birth**.
- Then, it becomes fibrosed and is called the **vestige of processus vaginalis**.
- The **tunica vaginalis** is composed of a **visceral** and a **parietal** layer which are separated by the cavity of **tunica vaginalis**.



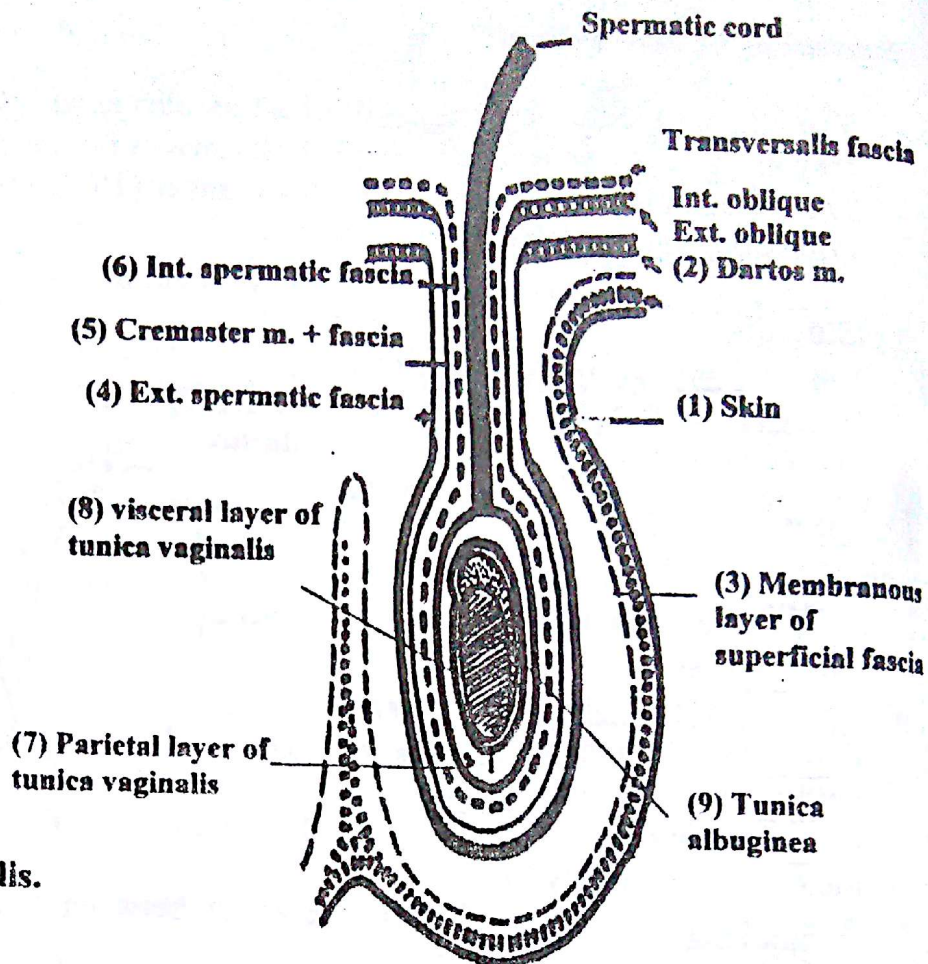


Coverings of the testis

As the testis descends into the scrotum it carries around it coverings which represent the different layers of the anterior abdominal wall.

From outside inwards, these coverings are:

- 1) Skin.
- 2) Dartos muscle.
- 3) Membranous layer of superficial fascia.
- 4) External spermatic fascia (from external oblique muscle).
- 5) Cremaster muscle and fascia (from internal oblique muscle).
- 6) Internal spermatic fascia (from fascia transversalis).
- 7) Parietal layer of tunica vaginalis.
- 8) Visceral layer of tunica vaginalis.
- 9) Tunica albuginea (fibrous capsule of the testis).



Spermatic cord

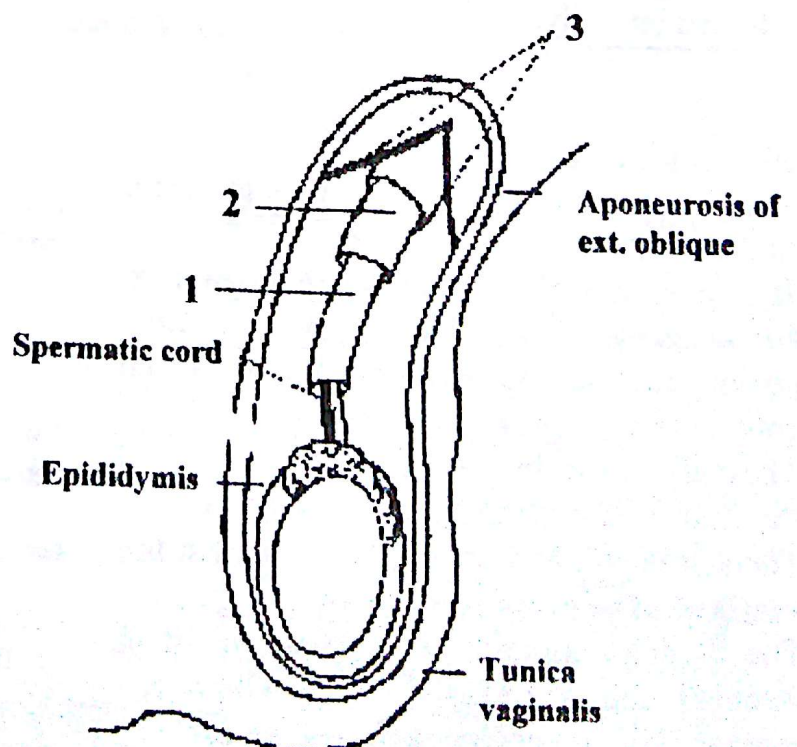
As the testis descends into the scrotum it drags with it the Vas deferens, and the vessels and nerves of the testis.

At the deep inguinal ring these structures are grouped together to form the spermatic cord.

The latter extends through the inguinal canal to the posterior border of the testis.

Coverings of the cord

1. Internal spermatic fascia: which extends around the cord from the deep inguinal ring, and is a derivative of the fascia transversalis.
2. Cremaster muscle and fascia: which is a derivative of the internal oblique muscle.
3. External spermatic fascia: which extends around the cord from the superficial inguinal ring and is a derivative of the external oblique aponeurosis.



Structure of the cord

The cord is composed of several structures connected together by areolar tissue:

- 1) Ductus deferens (vas deferens).
- 2) Testicular artery.
- 3) Pampiniform plexus of veins.
- 4) Lymph vessels of the testis.
- 5) Cremasteric artery.
- 6) Genital branch of genitofemoral nerve.
- 7) Testicular plexus of sympathetic nerve fibers.
- 8) Artery of vas deferens,
- 9) Vestigial of processus vaginalis peritonei.

- The artery of the ductus deferens is a branch of the inferior vesical artery.
- The testicular artery is a branch of the abdominal aorta. It will be described later.
- The cremasteric artery is a branch of the inferior epigastric artery.

Pampiniform plexus of veins:

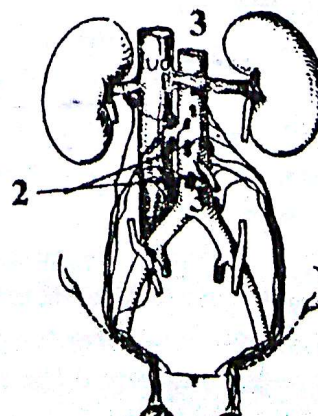
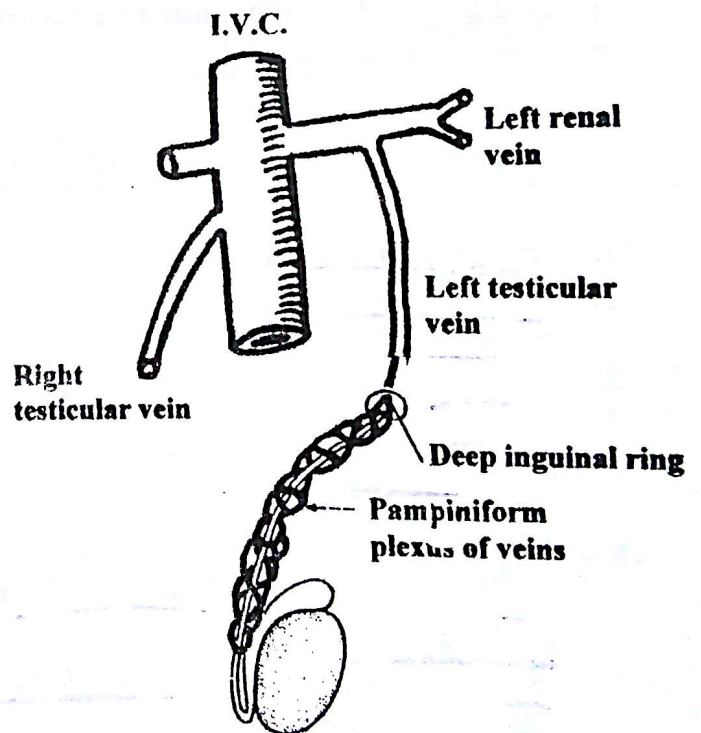
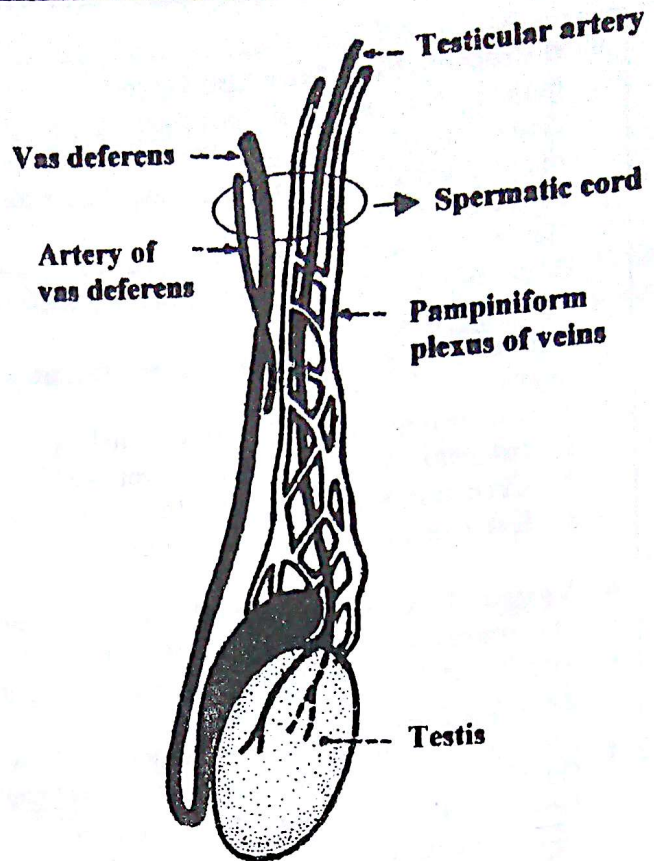
- It is formed of veins from the testis and epididymis.
- It forms the chief mass of the spermatic cord.
- These veins unite together as they ascend through the cord.
- At the deep ring they form one vein which is called the testicular vein.
- On the right side, the right testicular vein ends in the inferior vena cava (at acute angle).
- On the left side, the left testicular vein ends in the left renal vein (at right angle).

Varicocoele

- This is dilatation and enlargement of the pampiniform plexus of veins of the testis.
- It occurs more on the left side because of the pressure of the descending colon on the left testicular vein.

Lymphatic drainage of the testis:

- The lymphatic vessels from the testis(1), according to the testicular vessels to the abdomen.
- They end in the para aortic lymph nodes(2) along side the abdominal aorta(3).



Remember that about the testis:

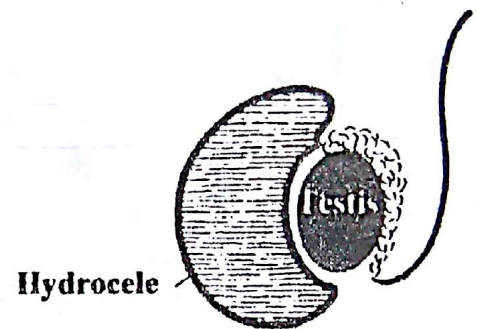
- In the embryo: it is developed inside the abdomen.
- About 28 of intrauterine life, the testis migrates downwards through the inguinal canal to reach the scrotum (outside the abdominal cavity) at about 32 week.
- However it preserves its abdominal blood supply and lymphatic drainage.
- It is supplied by the testicular artery which is a branch of abdominal aorta at the level of 3rd lumbar vertebra.
- It drains its lymph to the para-aortic and lateral aortic lymph nodes along side the abdominal aorta.
- During its migration inside the inguinal canal, the testis receives 3 important covering:
 1. Internal spermatic fascia → from fascia transversalis.
 2. Cremasteric muscle & fascia → from internal oblique muscle.
 3. External spermatic fascia → from the aponeurosis of the external oblique muscle.



- **Varicocele:** It is abnormal dilation & tortuosity of the pampiniform plexus of veins. It is more common on the left side because:

1. The left testicular vein is compressed along its course by the descending colon.
2. The left testicular vein drains its blood to the left renal vein (in which the venous pressure high) at right angle. However the right vein drains its blood directly to the superior vena cava at acute angle (which has low venous pressure).

- **Hydrocele:** It is the abnormal accumulation of fluid within the tunica vaginalis.



Abdominal planes

1. Lateral vertical plane.
2. Transpyloric plane.
3. Subcostal plane.
4. Umbilical plane.
5. Supracristal.
6. Intertubercular plane.

Lateral vertical plane:

This is a plane drawn vertically from the mid-inguinal point (right and left).

It also corresponds to the mid-clavicular or mammary lines.

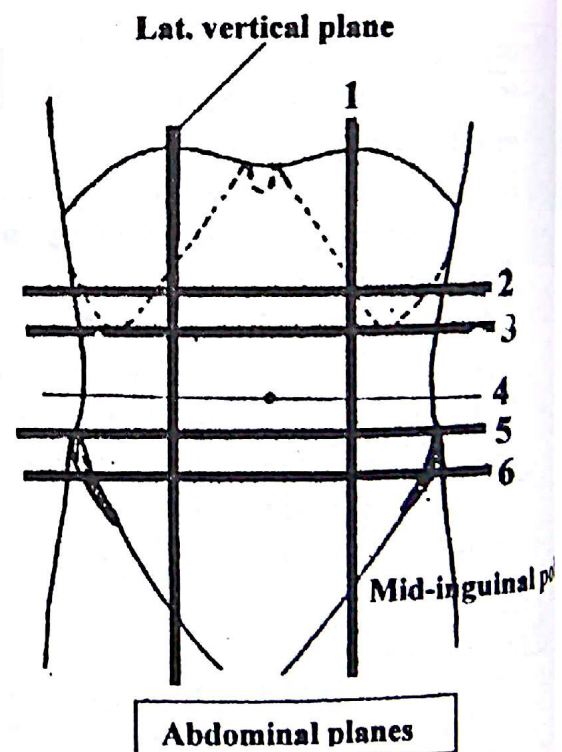
Transpyloric plane:

This is a transverse plane which is drawn by one of the following methods:

- a. Midway between the xiphisternum and umbilicus.
- b. Midway between the suprasternal notch and the border of symphysis pubis.
- c. A hand's breadth below the xiphisternum.

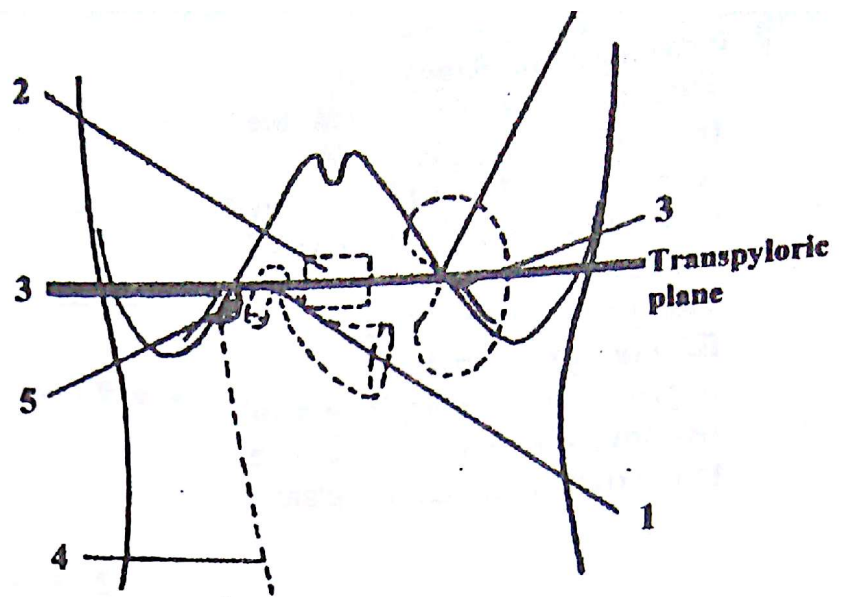
The transpyloric plane passes across many important structures:

- It cuts the pylorus of the stomach(1).
- It cuts the body of the first lumbar vertebra(2).
- It cuts the costal margin at the tip of the 9th costal cartilage(3).



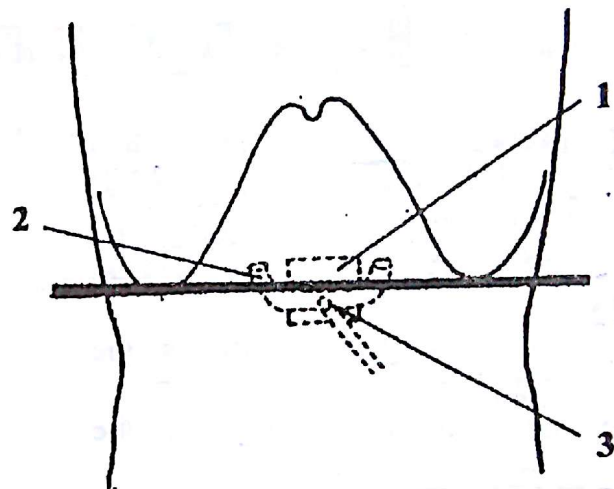
Abdominal planes

- The transpyloric plane passes on the **upper end of the linea semilunaris(4)** (lateral border of rectus abdominis muscle).
- It cuts the **fundus of the gall bladder(5)** at the tip of the right ninth costal cartilage and the upper end of the right linea semilunaris.
- It cuts the **hilum of the left kidney(6)** opposite the tip of the left ninth costal cartilage.
However, the hilum of the right kidney is about half an inch lower than this plane.



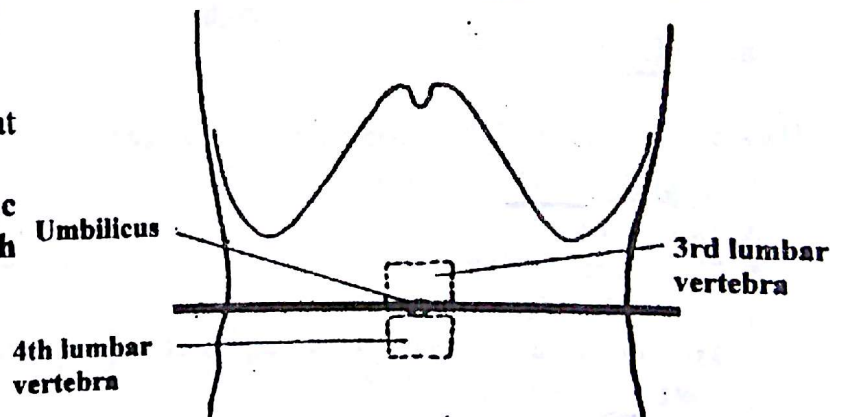
Subcostal plane:

- This is a plane drawn transversely at the level of the lowermost limit of the costal margin as seen from in front, i.e. lower border of the tenth costal cartilages.
- This plane cuts the body of the third lumbar vertebra(1).
It passes on the third part of the duodenum(2) and the origins of the inferior mesenteric and gonadal arteries(3).



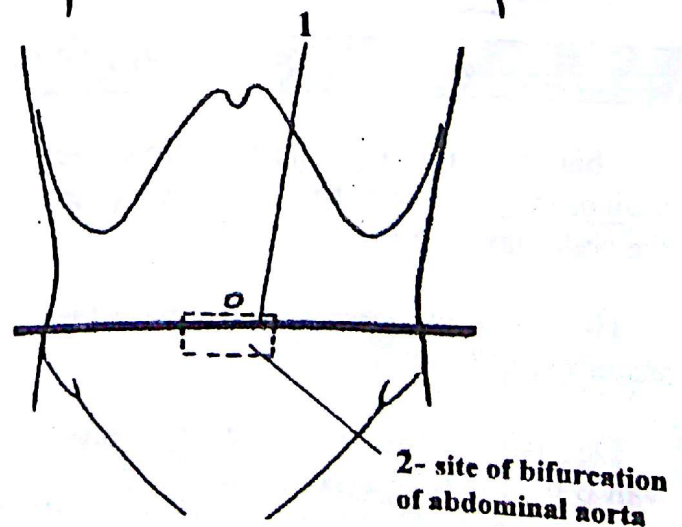
Umbilical plane:

- This is a plane drawn transversely at the level of the umbilicus.
- This plane passes on the disc between the third and fourth lumbar vertebrae.



Supracristal plane:

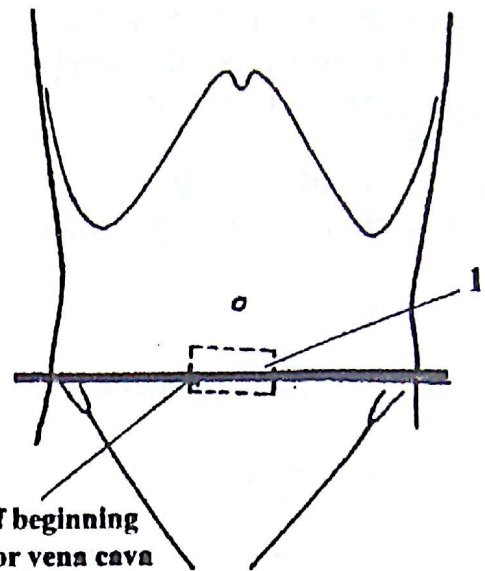
- This plane is also called the plane of the highest point of iliac crests.
- It is a plane drawn transversely at the level of the highest points of the two iliac crests.
- It cuts the body of the fourth lumbar vertebra(1).
- This plane passes on the bifurcation of the abdominal aorta(2) half an inch to the left of the median plane.



Intertubercular plane:

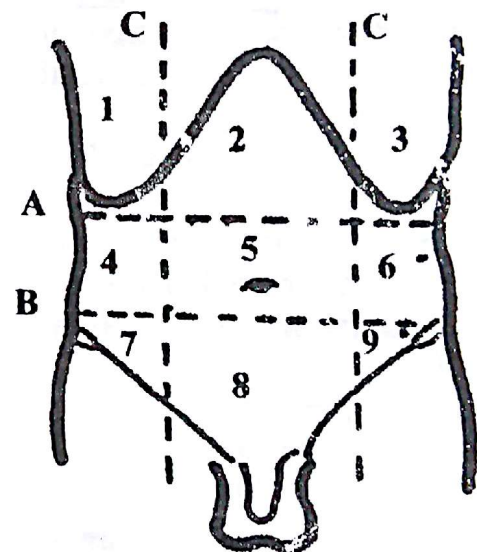
- This plane is also called the **transtubercular plane**.
- It is a plane drawn transversely at the level of the **tubercles of the iliac crests**.
- This plane cuts the body of the **fifth lumbar vertebra(1)**.
- It passes on the **beginning of the inferior vena cava(2)** one to the right of the median plane.

2- site of beginning
of inferior vena cava



Subdivisions of the abdominal cavity

- For purposes of description and location of the viscera, the abdominal cavity is divided into nine regions by two transverse and two vertical planes.
- The upper transverse plane is the subcostal plane(A).
- The lower transverse plane is the intertubercular plane(B).
- The two vertical planes are the right and left lateral vertical planes(C).



The subdivisions of the abdominal cavity are:

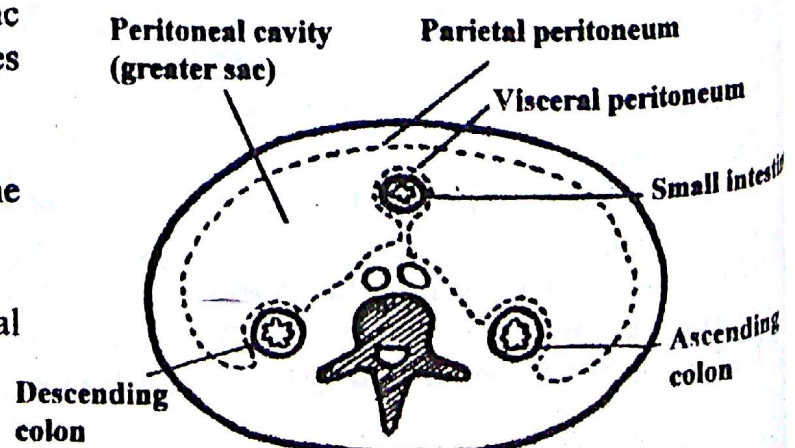
- | | |
|--|---------------------------------|
| 1. <u>Right hypochondrium</u> . | 2. <u>Epigastrium</u> . |
| 3. <u>Left hypochondrium</u> . | 4. <u>Right lumbar region</u> . |
| 5. <u>Umbilical region</u> . | 6. <u>Left lumbar region</u> . |
| 7. <u>Right iliac fossa (or region)</u> . | |
| 8. <u>Hypogastrium (hypogastric region or suprapubic region)</u> . | |
| 9. <u>Left iliac fossa (or region)</u> . | |

PERITONEUM

This is a large complicated serous sac which, in part, covers the viscera and lines the abdominal wall.

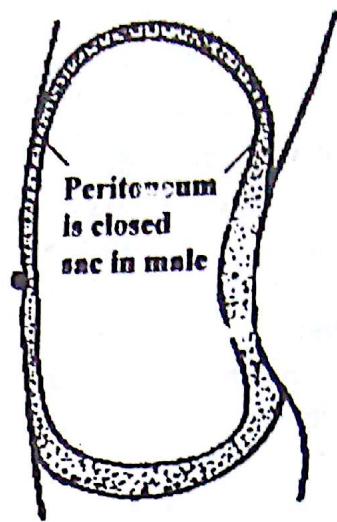
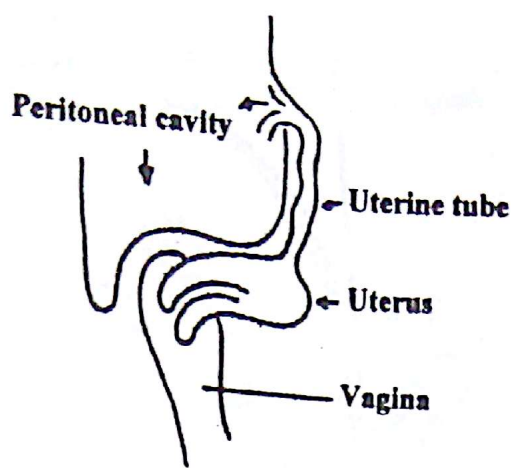
The part which covers the viscera is the visceral peritoneum.

The part which lines the abdominal wall is the parietal peritoneum.

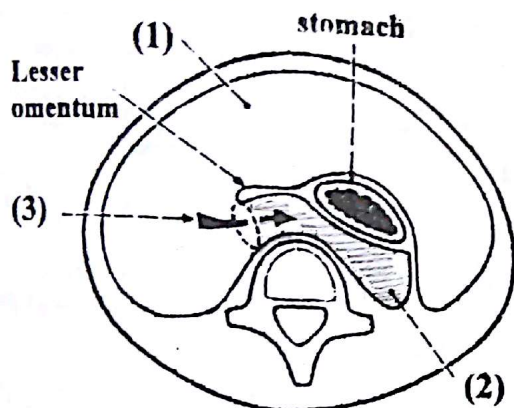


The peritoneum is a completely closed sac in male.

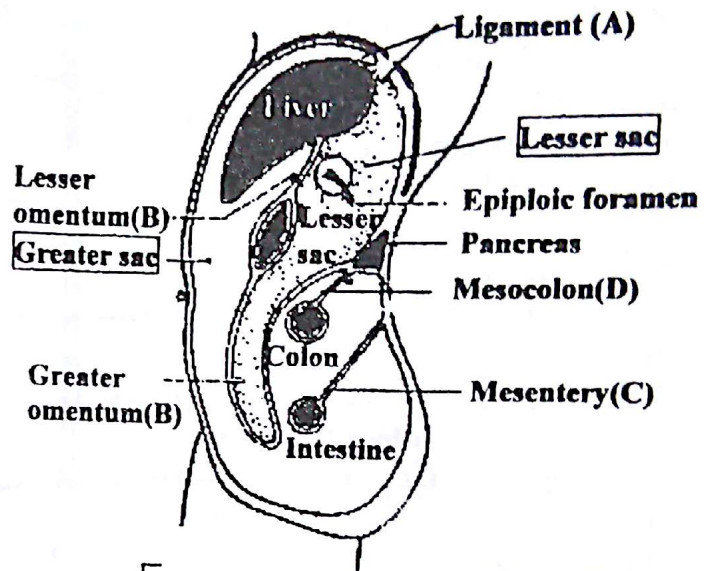
In female, however, the sac is not completely closed because the free ends of the uterine tubes open into the peritoneal cavity.



- The peritoneal cavity is divided into two main parts: (1) the greater sac and (2) lesser sac.



Transverse section of abdomen showing the greater & lesser sacs and epiploic foramen



Sagittal section of abdomen showing the greater & lesser sacs and the folds of peritoneum

- The greater sac forms most of the peritoneal cavity.
- While the lesser sac (2) is small cavity situated behind the stomach and lesser omentum.

The communication between the two sacs is called the opening into the lesser sac or epiploic foramen (3).

The peritoneum forms many folds which carry different names according to their position e.g. (A) ligament, (B) omentum, (C) mesentery and (D) mesocolon.

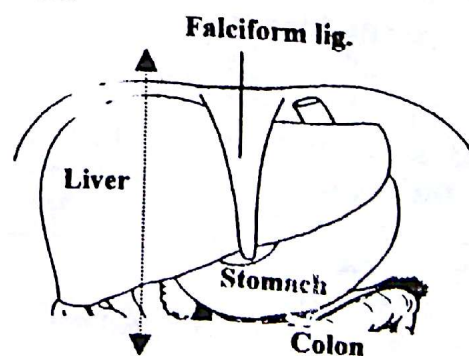
Greater sac of peritoneum

This is the part of the peritoneal cavity which lies just behind the anterior abdominal wall.

To understand the extent of the greater sac, it is followed in a vertical direction.

Vertical disposition of the greater sac:

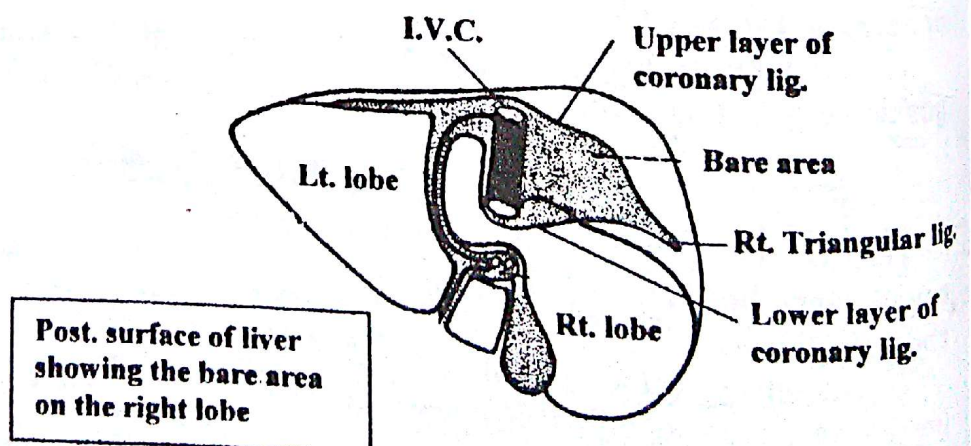
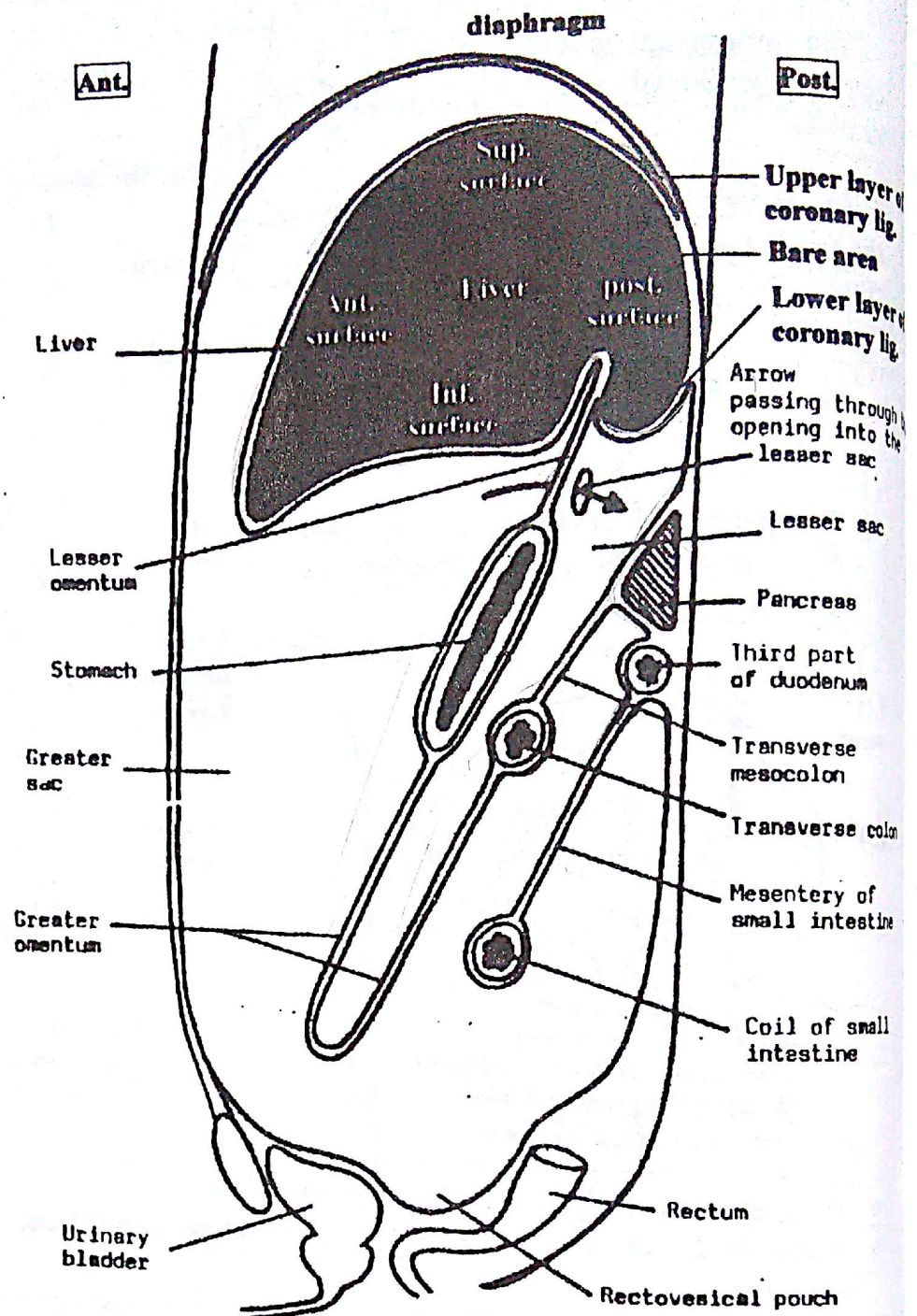
- Follow the peritoneum on the inner aspect of the anterior abdominal wall upwards on the right side of the falciform ligament.



A line represents the site of sagittal section in the abdomen in the right side of the falciform lig.

- The peritoneum continues on the under surface of the diaphragm.
- The peritoneum is reflected from the under surface of the diaphragm on to the superior surface of the liver.
- This reflection is called the upper layer of coronary ligament.
- The peritoneum can be followed from the superior surface of the liver down to the anterior surface of the liver.
- Then, it is followed into the inferior (visceral) surface of the liver.
- From the posterior part of the inferior surface of the liver, the peritoneum is reflected on the structures on the posterior abdominal wall (front of the right kidney and suprarenal gland).
- This reflected is called the lower layer of coronary ligament.
- The upper and lower layers of the coronary ligament bound a large area on the posterior surface of the liver which has no peritoneal covering.

- Accordingly, this area is called the bare area of the liver which is triangular in outline. If you follow the upper and lower layers of the coronary ligament to the right, they approach each other and meet together at the apex of the bare area to form the right triangular ligament.



Post. surface of liver showing the bare area on the right lobe

Follow the peritoneum downwards from the front of the right kidney(1) down to the front of the duodenum(2) and right colic flexure(3) (all these structures lie on the posterior abdominal wall).

Just above the duodenum, the peritoneum passes medially in front of the inferior vena cava(4) where it forms the posterior boundary of the epiploic foramen (opening into lesser sac).

The opening is the only connection between the greater and lesser sacs.

Follow the peritoneum on the inner aspect of the anterior abdominal wall on the left side of the falciform ligament.

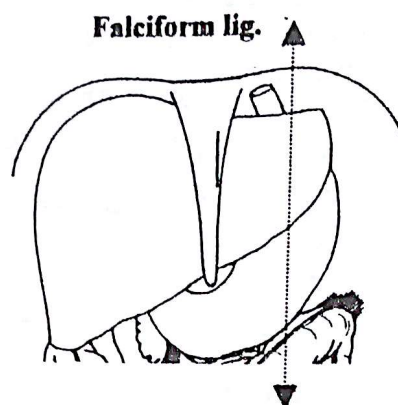
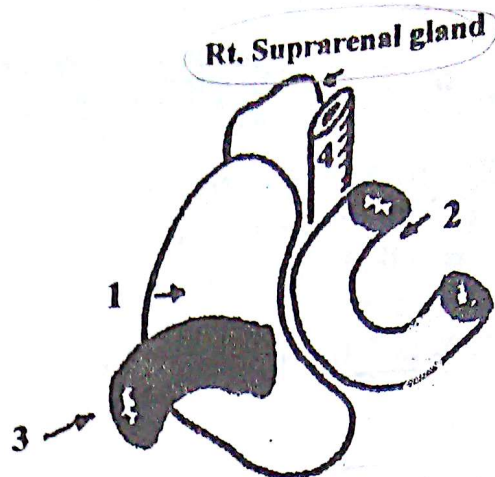
The peritoneum continues on the under surface of the diaphragm.

The peritoneum is then reflected on the posterior part of the superior surface of the left lobe of the liver.

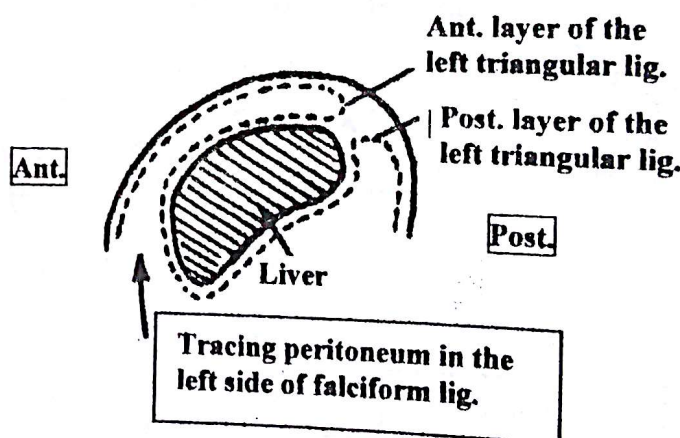
This reflection is called the anterior layer of the left triangular ligament.

The peritoneum is then followed from the superior surface to the anterior and inferior surface of the left lobe of the liver.

Then, the peritoneum is reflected on to the diaphragm where it forms the posterior layer of the left triangular ligament.



A line represents the site of sagittal section in the abdomen in the left side of the falciform lig.



- If you retract the stomach down away from the liver (the illustration in page 26), a well-defined peritoneal fold is seen connecting the liver with the stomach.

This fold is called the lesser omentum (gastrohepatic omentum).

This fold is formed of two layers of peritoneum.

The two layers separate to enclose the stomach and then come close together at the greater curvature of the stomach where they form a larger peritoneal fold called the greater omentum (gastrocolic omentum).

The two layers of the greater omentum descend down for a variable distance and then recur up to be attached to the transverse colon.

The two layers will enclose the transverse colon and then continue up as the transverse mesocolon.

The transverse mesocolon ascend upwards till it reaches the anterior border of the pancreas where it divides into two layers

- The upper layer continued on the posterior abdominal wall.
- The lower layer descends from the anterior border of the pancreas downwards.

It covered the lower part of the head of pancreas, inferior surface of the body of pancreas, duodenum, ureters and muscles, vessels and nerves on the posterior abdominal wall.

The peritoneum covering the structures on the abdominal wall shows a reflection along the course of the superior mesenteric vessels.

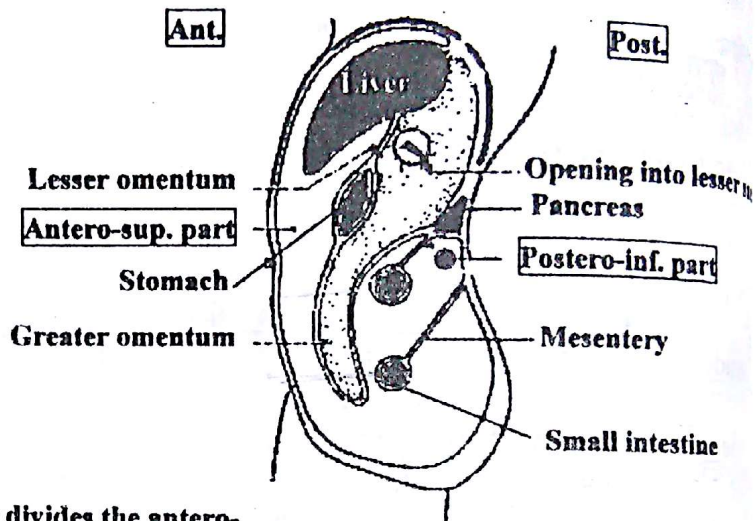
This reflection is called the mesentery of the small intestine as it encloses the free part of the small intestine.

If the peritoneum is followed down, it continues into the pelvis to form the pelvic peritoneum.

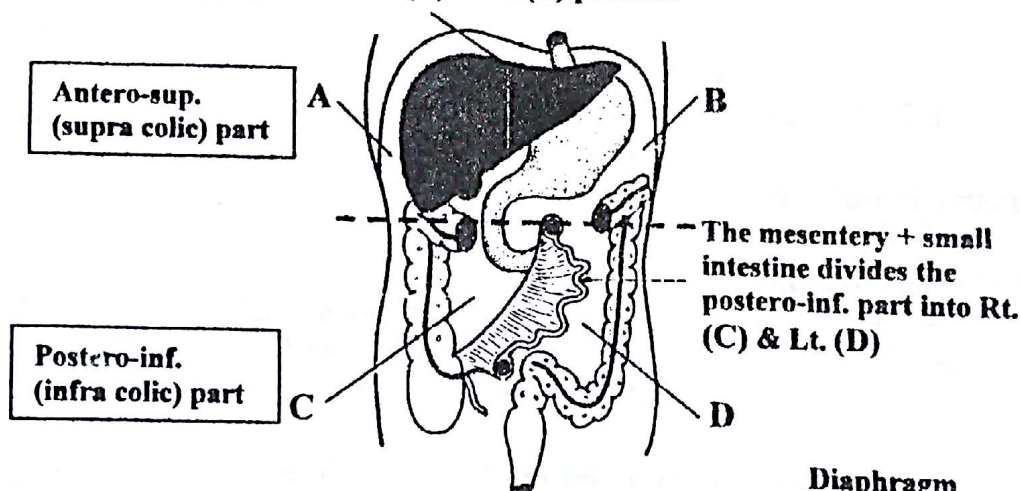
Subdivision of the greater sac

The lesser omentum, stomach, greater omentum, transverse colon and transverse mesocolon together form an incomplete partition which divides the greater sac into two parts:

1. Antero-superior (supra colic) part: which is incompletely divided into right(A) and left(B) portions by the falciform ligament.
2. Postero-inferior (infra colic) part: which is also incompletely divided into right(C) and left(D) portions by the mesentery and the small intestine.



Site of falciform lig. which divides the antero-sup. part into Rt.(A) & Lt.(B) portions



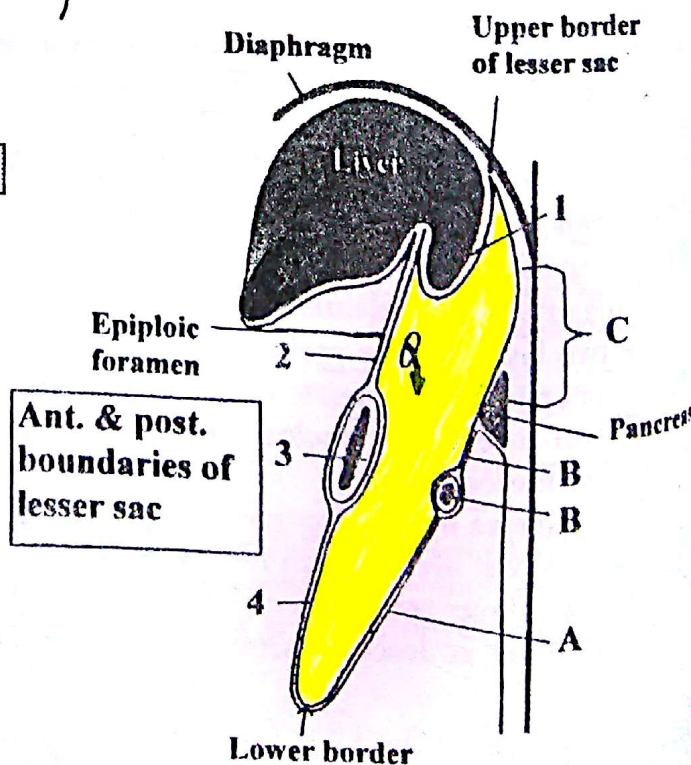
Lesser sac of peritoneum

This is a large peritoneal recess which lies behind the stomach and within the greater omentum.

It is completely separated from the greater sac except for a single opening in the upper part of its right border.

This opening is called the opening into the lesser sac or the epiploic foramen.

- The lesser sac has the following boundaries:



Anterior wall: is formed, from above downwards by:

- (1) Peritoneum on the caudate lobe of liver.
- (2) Lesser omentum,
- (3) Peritoneum on the back of the stomach and greater omentum.
- (4) Anterior two layers of the

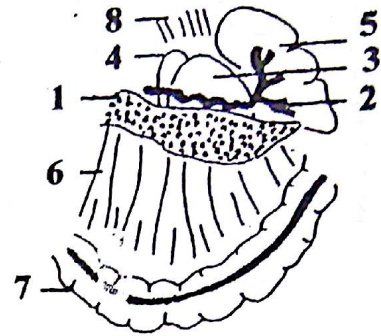
Structures of stomach bed

Posterior wall: is formed from below upwards by:

- (A) The posterior two layers of the greater omentum,
- (B) Transverse colon & mesocolon,
- (C) Peritoneum covering the structures on the posterior abdominal wall which form the stomach bed.

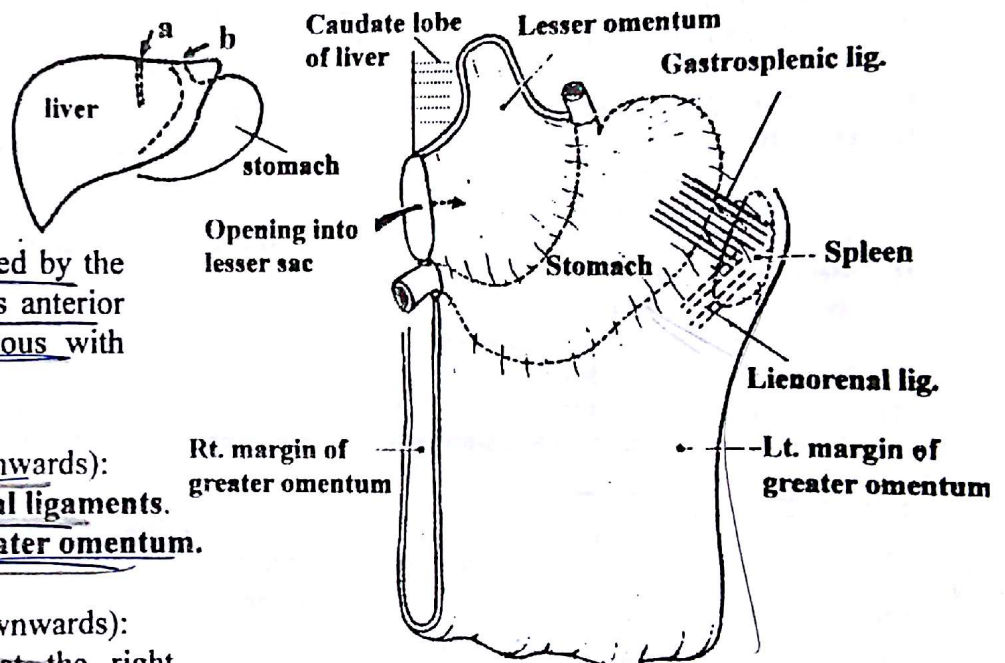
These structures are:

- Pancreas(1).
- Upper part of left kidney(3).
- Spleen (gastric impression) (5).
- Left crus of diaphragm(8).
- Splenic artery(2).
- Left supra renal gland(4).
- Transverse mesocolon(6) + colon(7).



Upper border: which is formed by reflection of the peritoneum of the posterior layer of the lesser omentum (anterior wall) on to the diaphragm (posterior wall).

This border extends between the fissure for the ligamentum venosum(a) of the liver and the lower end of the esophagus(b).



Lower border: which is formed by the greater omentum where its anterior two layers become continuous with its posterior two layer.

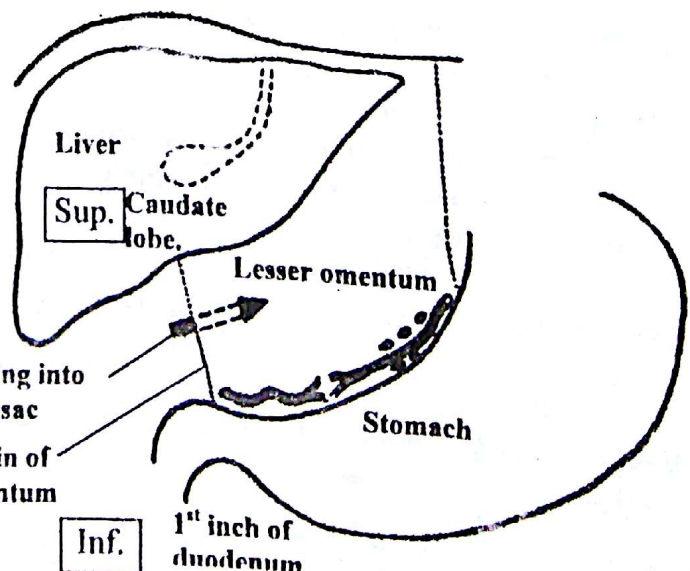
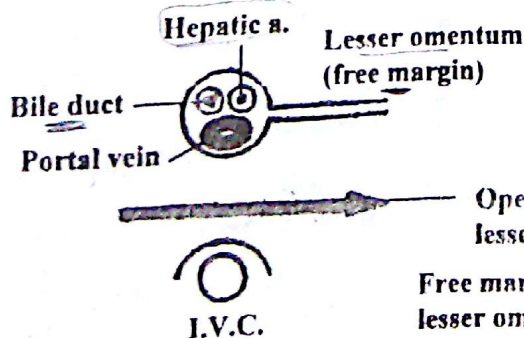
Left border: (from above downwards):

- 1) Gastrosplenic and lienorenal ligaments.
- 2) Left free margin of the greater omentum.

Right border: (from above downwards):

- 1) Reflection of peritoneum at the right margin of the caudate lobe of the liver.
- 2) Opening into lesser sac
- 3) Right free margin of the greater omentum.

Opening into the lesser sac (epiploic foramen):



The opening into lesser sac is a slit-like aperture which communicates the cavity of the lesser sac with the greater sac.

It lies behind the free (right) margin of the lesser omentum.

This opening has four boundaries: (the illustrations in page 29)

1. Anterior boundary: the structures in the margin of the lesser omentum which are:
a) the portal vein, b) hepatic artery and c) bile duct.

The portal vein is posterior to the other two structures.

The hepatic artery is anterior and to the left, while the bile duct is anterior and to the right.

2. Posterior boundary: peritoneum covering the inferior vena cava.
3. Superior boundary (roof): peritoneum covering the caudate process of the caudate lobe of the liver.
4. Inferior boundary (floor): Peritoneum covering the first inch of the 1st part of the duodenum and the portal vein as it curves to enter the lesser omentum.

Folds of peritoneum

They are double layers of peritoneum connecting different abdominal organs.

Function:

1. They attach organs to each other or to the abdominal wall.
2. They allow free mobility to certain abdominal organs.
3. They act as media for the passage of vessels, nerves and lymphatics to the suspended organs.

Classification: peritoneal folds are classified into 3 types:

- I. **Omenta:** are peritoneal folds connecting the stomach to other organs. They include:
 1. **Lesser omentum:** between the stomach and the liver.
 2. **Greater omentum:** between the stomach and transverse colon.
 3. **Gastro splenic omentum (or ligament):** between the stomach and spleen.
- II. **Mesenteries:** peritoneal folds connecting the mobile parts of the intestine to the posterior abdominal wall. They include:
 1. **The mesentery of the small intestine.**
 2. **Transverse mesocolon.**
 3. **Sigmoid mesocolon.**
 4. **Mesoappendix.**
- III. **Ligaments:** include the rest of the peritoneal folds which connect abdominal organs together (**lienorenal ligament**) or to the abdominal wall (**coronary & triangular ligament**).

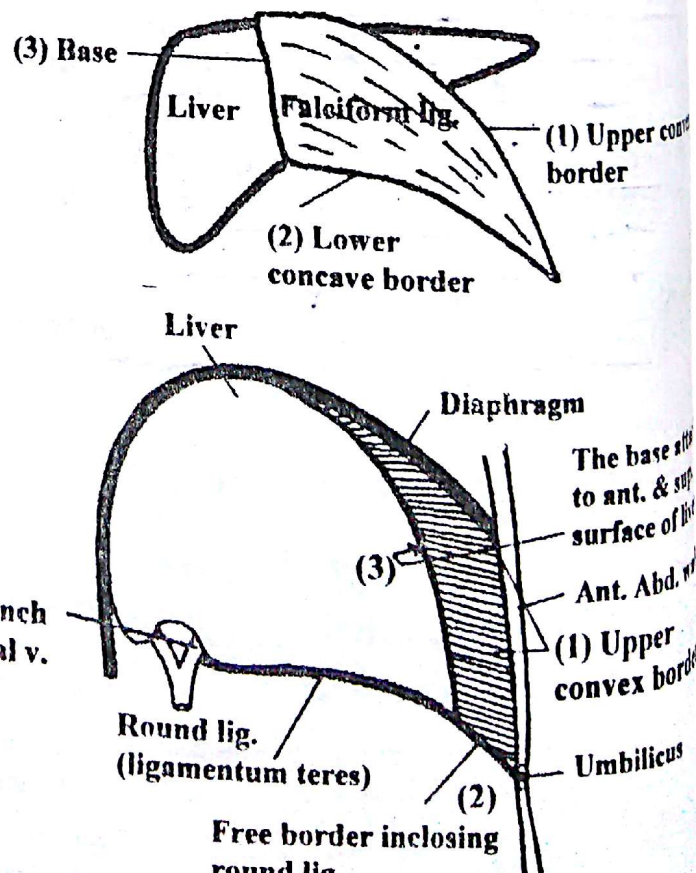
Falciform Ligament

This is a fold of peritoneum which connects the **anterior abdominal wall with the liver**, slightly to the right of the median plane.

- It is sickle-shaped, having three borders:

- (1) The **upper convex border** is attached to the **anterior abdominal wall** and the **under surface of the diaphragm**.
- (2) The **lower concave border** is a free border which extends from **umbilicus** to the **liver**, and encloses the **ligamentum teres** or **round ligament of the liver** (**obliterated umbilical vein**).
- (3) The **base** is attached to the **superior and anterior surfaces of the liver**.

The two layers of the falciform ligament are continuous at its free border.

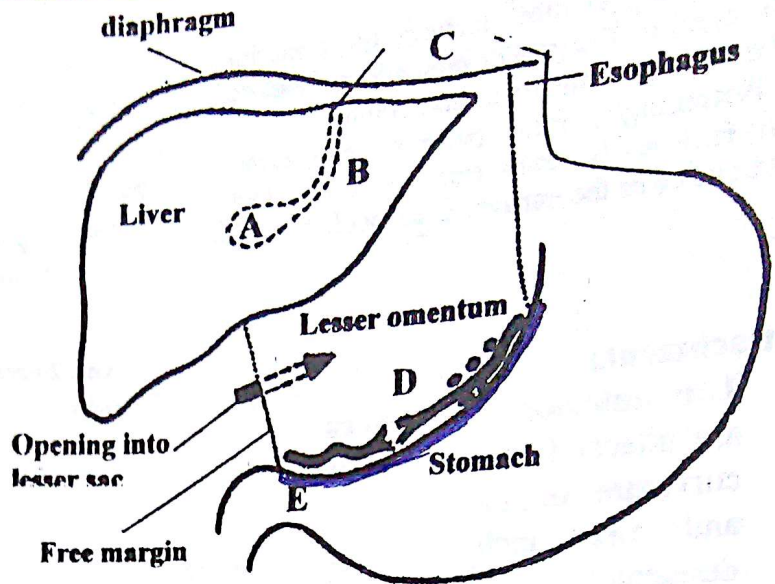


Lesser omentum

This is a fold of peritoneum from the liver to the lesser curvature of the stomach and first part of the duodenum.

Attachments:

1. To the margins of the porta hepatis (A) and the bottom of the fissure for ligamentum venosum (B).
2. To the diaphragm (C) between the liver and lower end of the esophagus.
3. To the lesser curvature of the stomach (D) and the first inch of the duodenum (E).

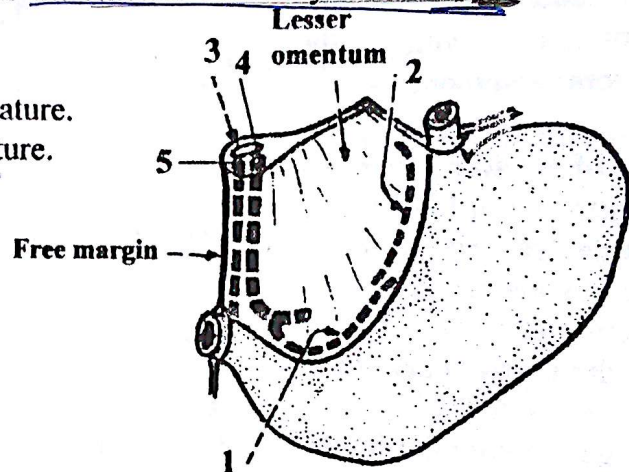


On the right side, the two layers of the lesser omentum are continuous with each other, forming its free margin.

4. This free margin extends from the porta hepatis of the liver and the first inch of the 1st part of the duodenum, and forms the anterior boundary of the opening into the lesser sac.

Contents of the lesser omentum:

1. Right gastric vessels along the lesser curvature.
2. Left gastric vessels along the lesser curvature.
3. Portal vein.
4. Hepatic artery.
5. Bile duct.
 - The portal vein, hepatic artery and bile duct run along the free margin of the lesser omentum.
 - The portal vein is posterior to the other two structures.
 - The hepatic artery is anterior and to the left.
 - The bile duct is anterior and to the right.
6. Sympathetic and parasympathetic fibers,
7. Extraperitoneal fatty tissue,

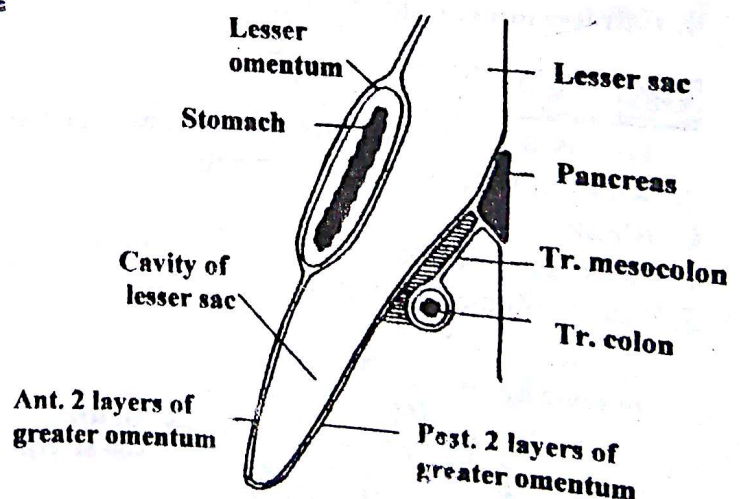


Greater Omentum

This is a large peritoneal fold which extends from the greater curvature of the stomach to the transverse colon.

The omentum is folded on itself, so that it is composed of four layers.

The cavity of lesser sac separates the anterior two layers from the posterior two layers.



Theories of formation of greater omentum

According to some authors, the posterior two layers of the greater omentum ascend up to be attached to the anterior border of the body of the pancreas.

However, these posterior two layers get closely adherent to the front of the transverse colon and mesocolon.

Accordingly, the posterior two layers of greater omentum appear as if they are attached to the transverse colon and not to the body of pancreas.

According to other authors, the posterior two layers of the greater omentum ascend up to be attached to the transverse colon.

Accordingly, these posterior two layers will enclose the transverse colon and then continue up as the transverse mesocolon.

Attachments:

- The anterior two layers are attached to the greater curvature of the stomach and first inch of the duodenum.
- The posterior two layers are attached to the front of the transverse colon where they separate to enclose the colon and then become continuous with the transverse mesocolon.

Contents of greater omentum:

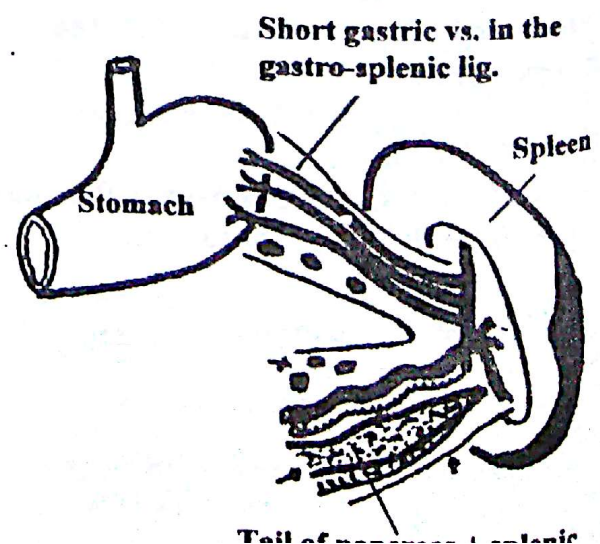
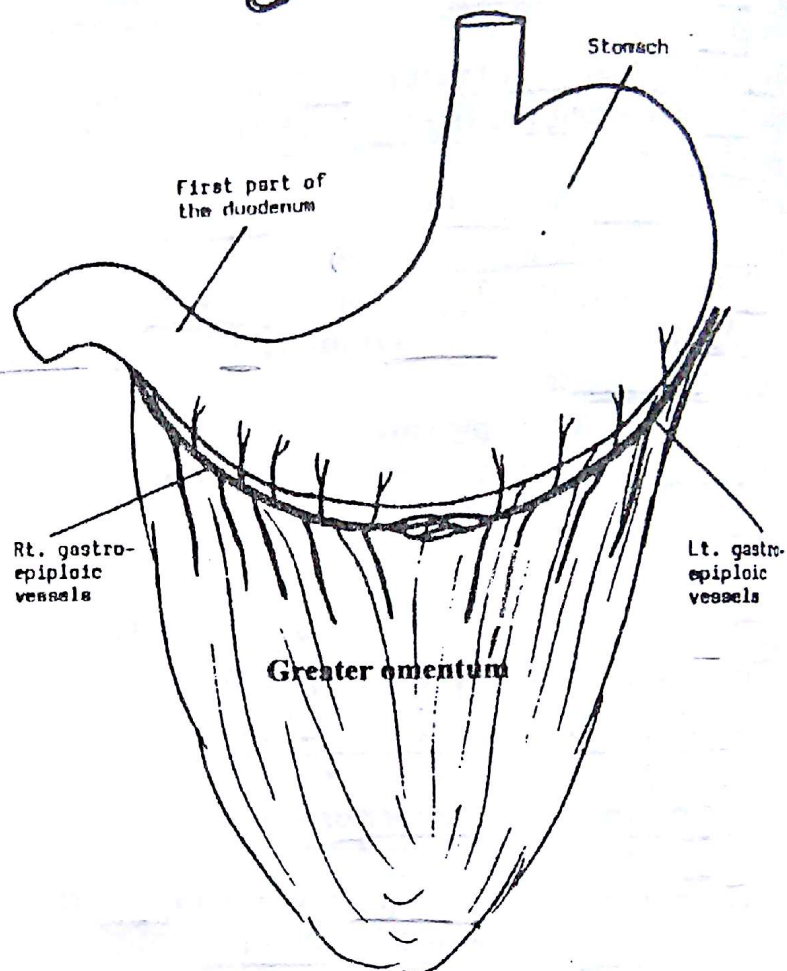
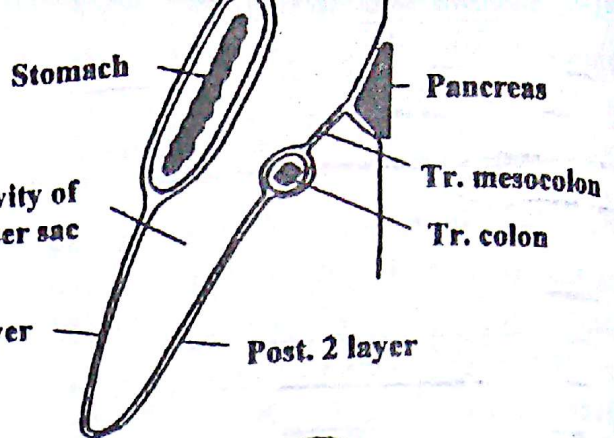
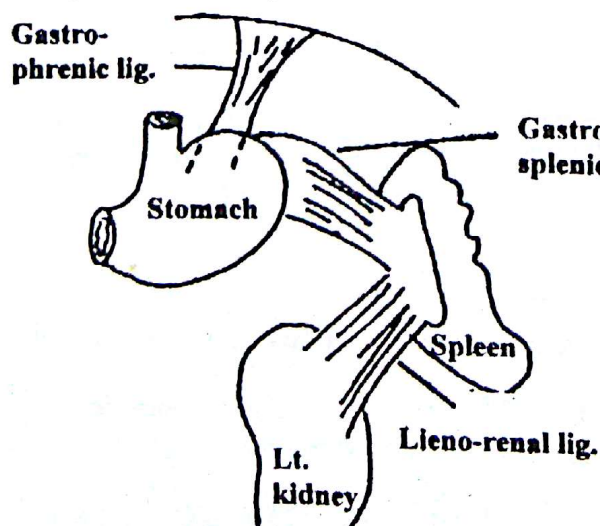
1. Left gastro-epiploic vessels.
2. Right gastro-epiploic vessels. These vessels run between the anterior two layers along the greater curvature of the stomach.
3. Right gastro-epiploic lymph nodes and lymph vessels.
4. Extraperitoneal fatty tissue.

Gastro-splenic ligament

This is a peritoneal fold which connects the spleen with the upper part of the greater curvature of the stomach.

Contents:

1. Short gastric vessels.
2. Gastro-splenic lymph nodes.
3. Extraperitoneal fatty tissue.



Lieno-renal ligament

This is a peritoneal fold which connects the front of the left kidney the spleen.

Contents:

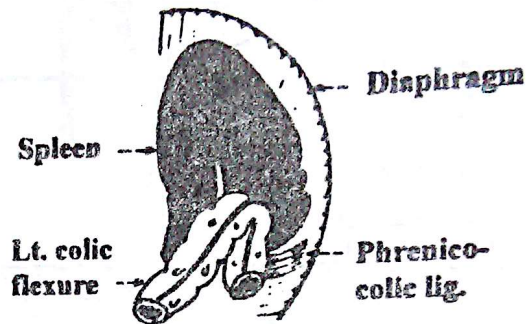
1. Splenic artery.
2. Splenic vein.
3. Tail of pancreas.
4. Pancreatico-splenic lymph nodes.
5. Extraperitoneal fatty tissue.

Gastro-phrenic ligament

This is a short peritoneal fold which connects the upper part of the posterior surface of the stomach with the diaphragm.

Phrenico-colic ligament

This is a short peritoneal fold which connects the left colic flexure to the diaphragm below the spleen.



Mesentery *Sheet*

This is a fan-shaped peritoneal fold (formed of two layers) which encloses the free part of the small intestine.

- Its free border (intestinal border) encloses the jejunum and ileum. Therefore, this border is nearly 20 feet in length.
- Its attached border (to the posterior abdominal wall) is called the root of the mesentery.

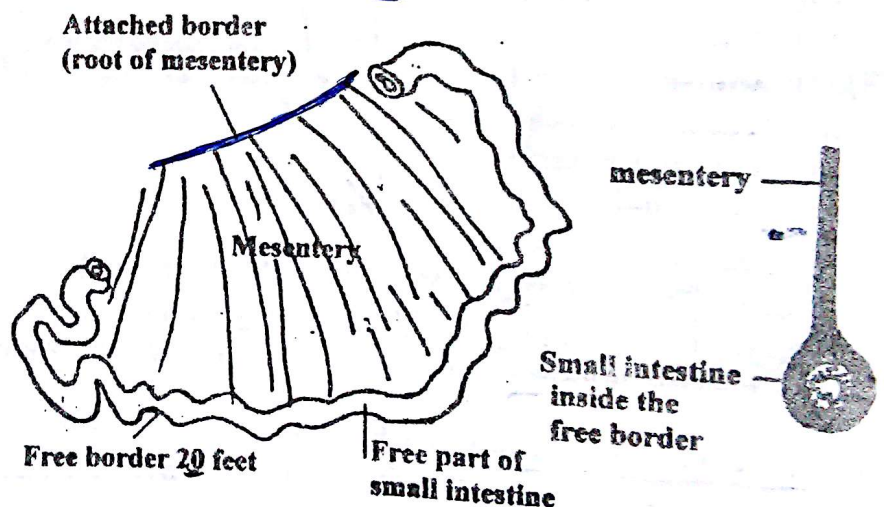
The root is about 6 inches in length.

As a result the mesentery widens greatly as we follow it from the root to the free border.

So, the mesentery is seen to form undulation or frills.

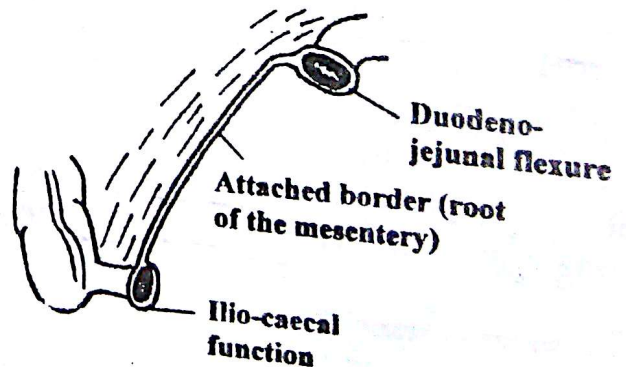
These undulations disappear at the root.

The mesentery is formed of two layers which are continuous at the root with the peritoneum of the posterior abdominal wall.



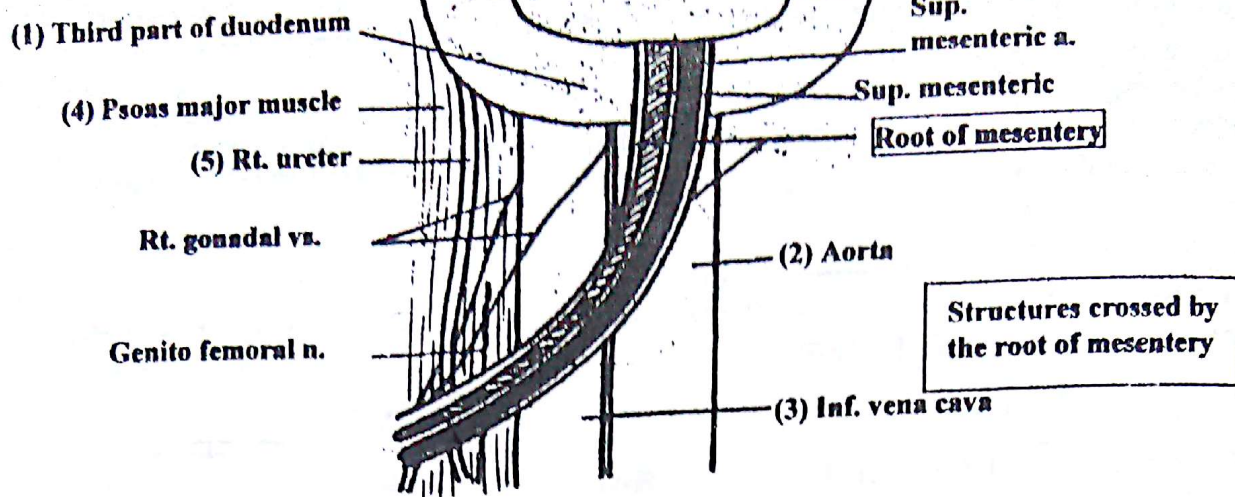
The root of the mesentery begins at the duodeno-jejunal flexure and ends at ileo-caecal junction.

It follows a curved course with a concavity towards the right side.



→ The root passes successively in front of:

1. the third part of the duodenum,
2. abdominal aorta,
3. inferior vena cava,
4. right psoas major and
5. right ureter.

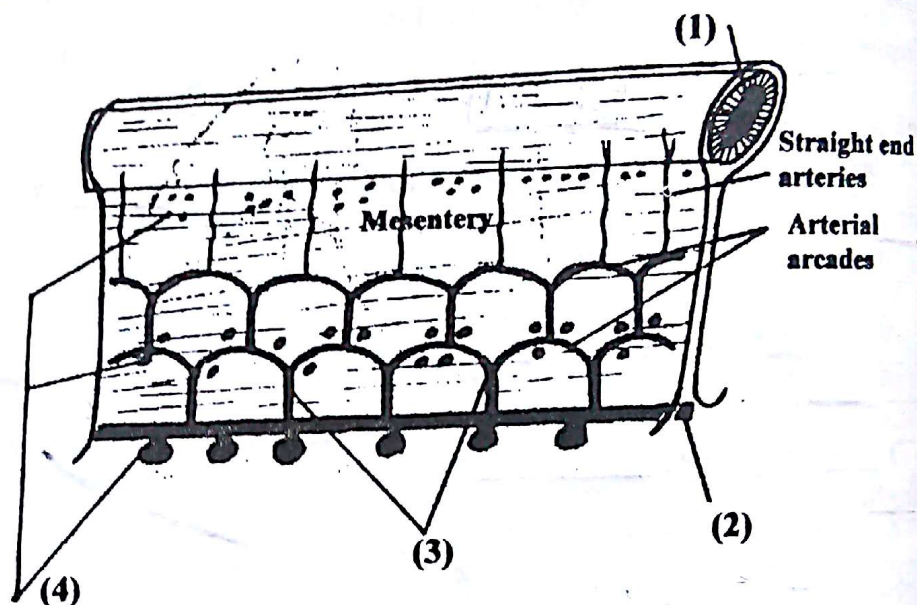


Contents of the mesentery

(1) Jejunum and ileum which run in the free border.

(2) Superior mesenteric vessels which run in the root of the mesentery.

(3) Jejunal and ileal branches of the superior mesenteric artery and the accompanying veins.



These vessels anastomose with each other in the mesentery to form arterial arcades from which straight end arteries arise to supply the small intestine.

The arcades are simple in the upper part of the mesentery and complicated in its lower part.

(4) Mesenteric lymph nodes which are very numerous and drain into the intestinal lymph trunk. The latter ends in the cisterna chyli.

(5) Extraperitoneal fatty tissue (mesenteric fat).

The amount of fat is little in the upper part of the mesentery where the two layers of peritoneum can get in contact with each other to form "windows".

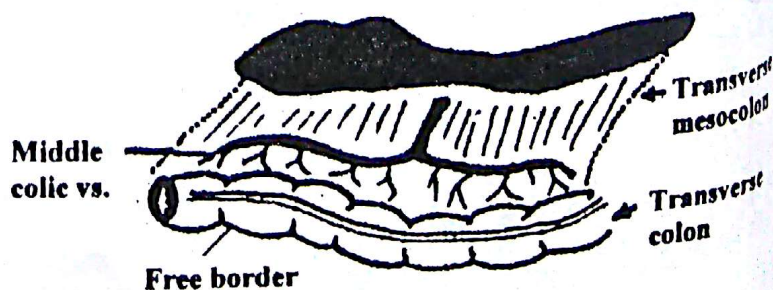
The amount of fat is dense in the lower part of the mesentery, and the two layers of peritoneum cannot get in contact with each other (i.e. no windows).

(6) A dense plexus of sympathetic nerve fibers which run with the jejunal and ileal branches of the superior mesenteric artery.

Transverse mesocolon

This is a peritoneal fold which encloses the transverse colon.

Its free border encloses the transverse colon; while its root is attached to the front of the head and the anterior border of the body of the pancreas.



Contents of transverse mesocolon:

1. Transverse colon.
3. Lymph vessels and lymph nodes.
5. Sympathetic fibers.

2. Middle colic vessels.
4. Extraperitoneal fatty tissue.

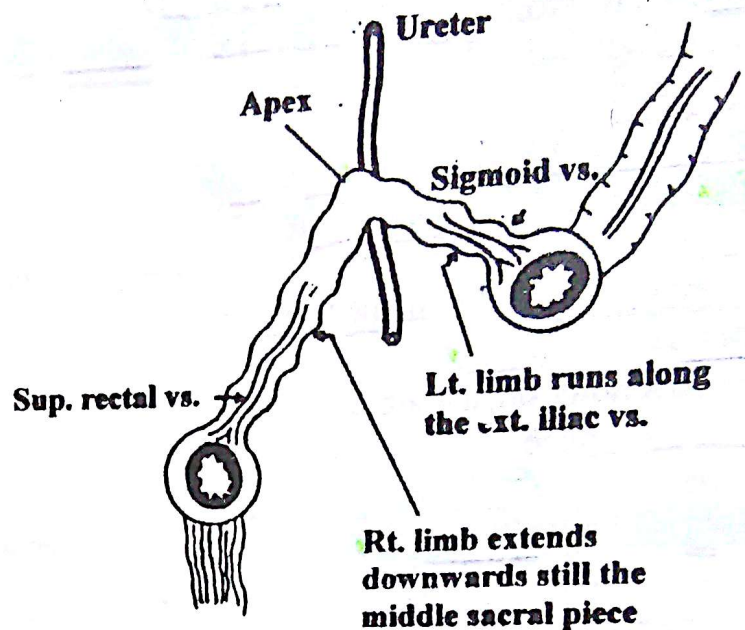
Pelvic (sigmoid) mesocolon

- This is a peritoneal fold which encloses the pelvic (sigmoid) colon.
- Its free border encloses the colon; while its root is attached along a line which is inverted V shaped.

The apex of the V is attached to the pelvic wall near the bifurcation of the left common iliac artery. It overlies the left ureter.

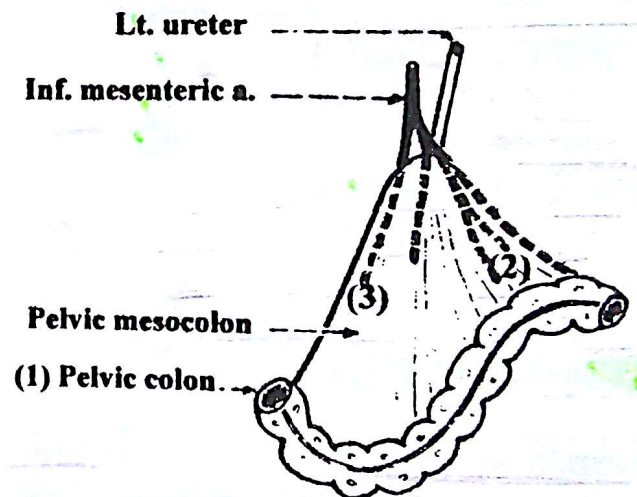
The left limb of the V runs along the left external iliac vessels.

The right limb of the descends into the pelvis in front of the sacrum; and ends opposite the middle (third) sacral piece.



Contents of the pelvic mesocolon:

1. Sigmoid (pelvic) colon.
2. Sigmoid arteries.
3. Superior rectal artery.
4. Lymph vessels and lymph nodes.
5. Extraperitoneal fatty tissue.
6. Sympathetic fibers.

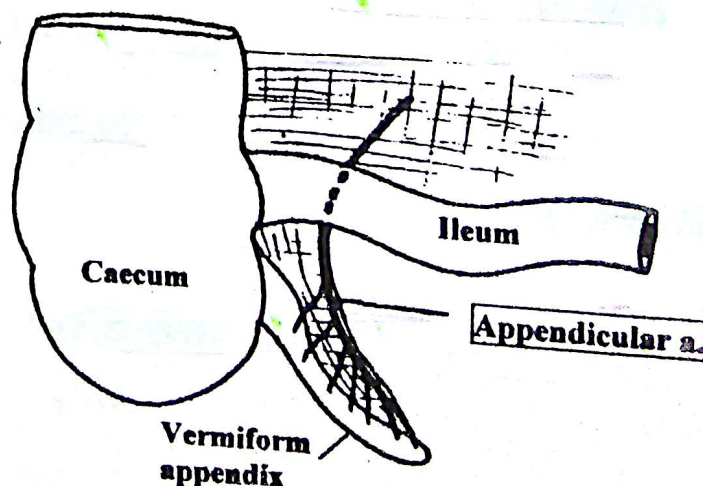


Mesoppendix

This is a triangular peritoneal fold which encloses the vermiform appendix.

Contents:

1. Vermiform appendix.
2. Appendicular artery and vein.
3. Lymph vessels and a lymph node.
4. Extraperitoneal fatty tissue.





Stomach

This is the most dilated part of the gut.

Position: The stomach lies in the left hypochondrium, epigastrium and umbilical regions.

Openings:

1. **Cardiac orifice:** about one inch to the left of the median plane.
2. **Pyloric orifice:** indicated by an anular groove (pyloric constriction) on the outer surface of the stomach. It lies about half an inch to the right of the median plane.

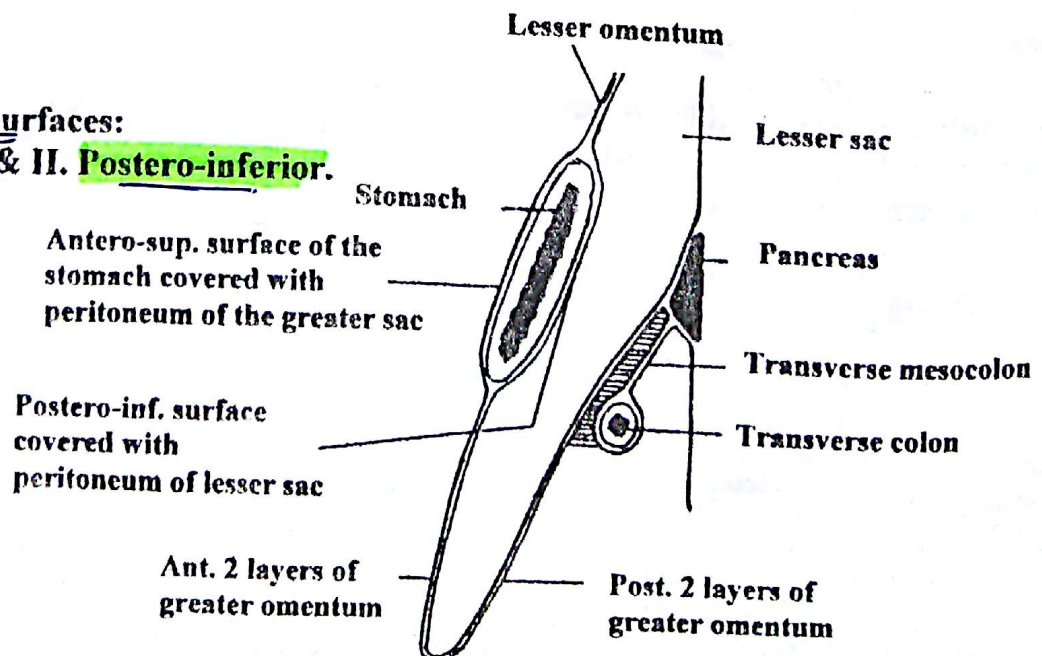
Borders :

1. **Lesser curvature:** which forms the right border of the stomach gives attachment to the lesser omentum; and the right and left gastric vessels run along it.
 - The most concave part of the lesser curvature presents a notch called the angular notch (incisura angularis).
2. **Greater curvature:** which is the left border of the stomach. It gives attachment to the gastrophrenic ligament, gastro-splenic ligament and greater omentum.
 - The right & left gastro-epiploic and short gastric vessels run along it.
 - The greater curvature presents a notch between it and the lower end of the esophagus which is called the cardiac notch (incisura cardiaca).

Surfaces:

The stomach has 2 surfaces:

I. **Antero-superior** & II. **Postero-inferior.**



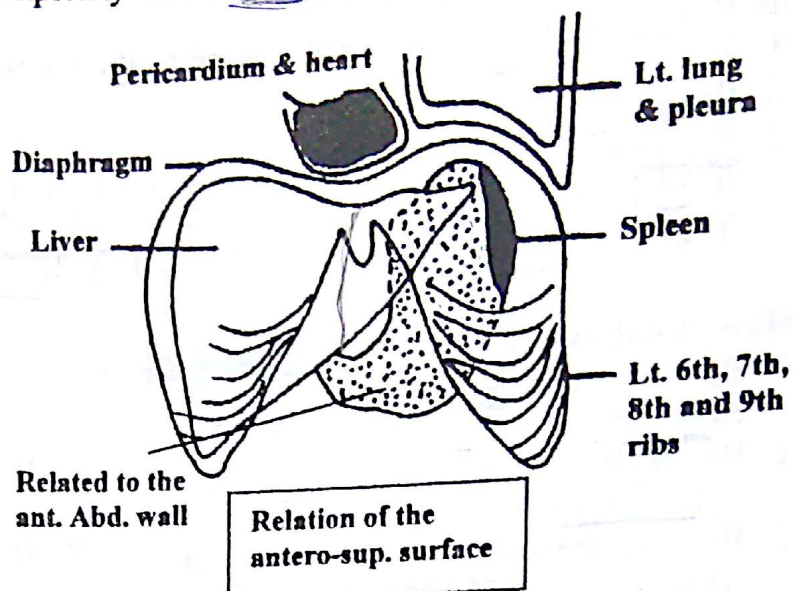
I. Antero-superior surface: which is completely covered by peritoneum of the greater sac. It is related to:

(1) The left lobe and quadrate lobe of the liver.

(2) It is also related to the diaphragm which separates it from the left pleura, the base of the left lung, the pericardium & the heart and the left 6th, 7th, 8th and 9th ribs.

(3) Anterior abdominal wall.

N.B.: The upper and left part of the antero-superior surface comes into relation with the gastric impression of the spleen.



II. Postero-inferior surface: which is covered by peritoneum of the lesser sac and is related to many structures which form the stomach bed.

These structures are:

(1) the left crus of diaphragm,

(2) a part of the left kidney,

(3) left suprarenal gland,

(4) splenic artery,

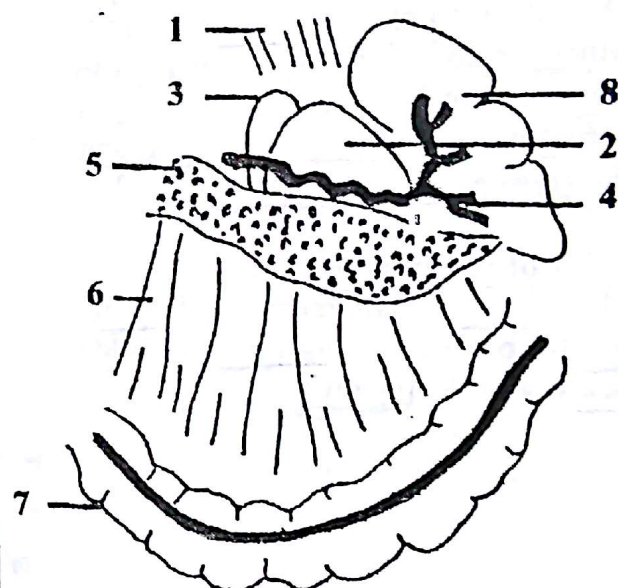
(5) anterior surface of pancreas,

(6) transverse mesocolon and

(7) transverse colon (if the mesocolon is not long).

- The structures forming the stomach bed are separated from the stomach by the cavity of the lesser sac.

(8) The spleen may be described as forming a part of the stomach bed, but it is separated from the stomach by a part of the greater sac.



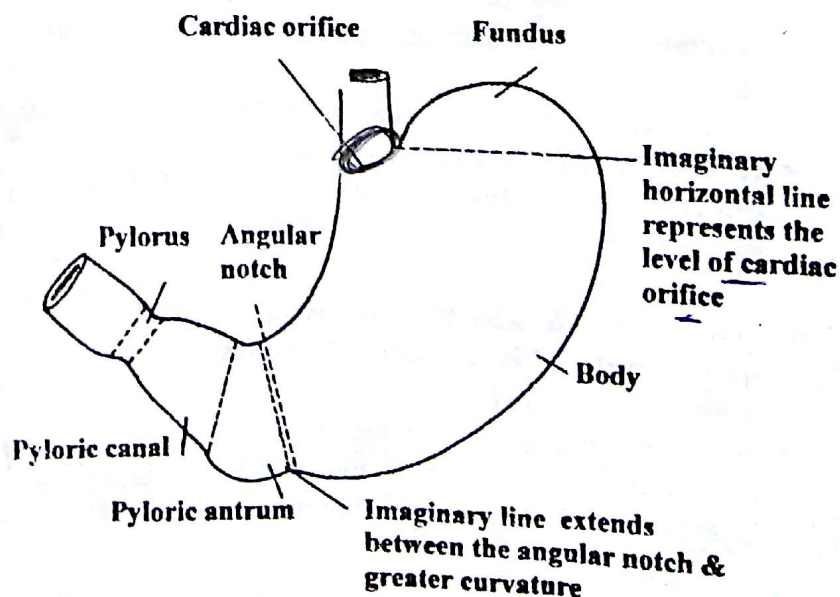
Structure forming the stomach bed (relations of the postero-inferior surface of the stomach).

Divisions of the stomach

A. Cardiac portion which is composed of two parts:

1. **Fundus** is the part above the level of the cardiac orifice.

2. **Body** which is the part that extends from the fundus to an imaginary line between the angular notch and the left side of the bulge on the greater curvature.



B. Pyloric portion which is composed of three parts:

1. Pyloric antrum.

2. Pyloric canal.

3. Pylorus which is the part corresponding to the pyloric orifice.

It is marked on the outside by the pyloric constriction

The pyloric orifice is surrounded by the thick pyloric sphincter.

How to define the pylorus in a living subject:

1. By the annular groove (pyloric constriction) which encircles it.

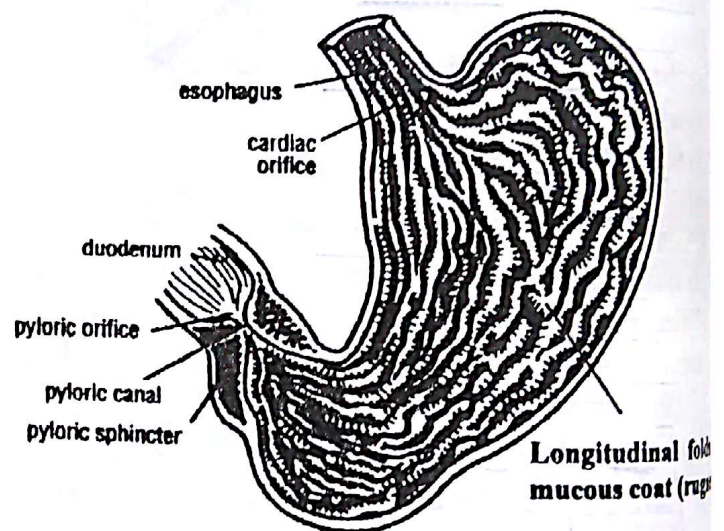
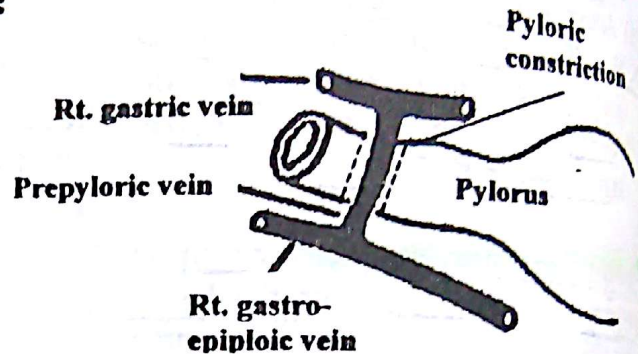
2. By feeling the thickness of the pyloric sphincter.

3. By the prepyloric vein (vein of Mayo).

This is a small, but constant, vein which runs vertically across the anterior surface of the pylorus between the right gastric vein and the right gastro-epiploic vein.

Interior of the stomach:

The mucous membrane of the empty stomach presents longitudinal folds which are called rugae.



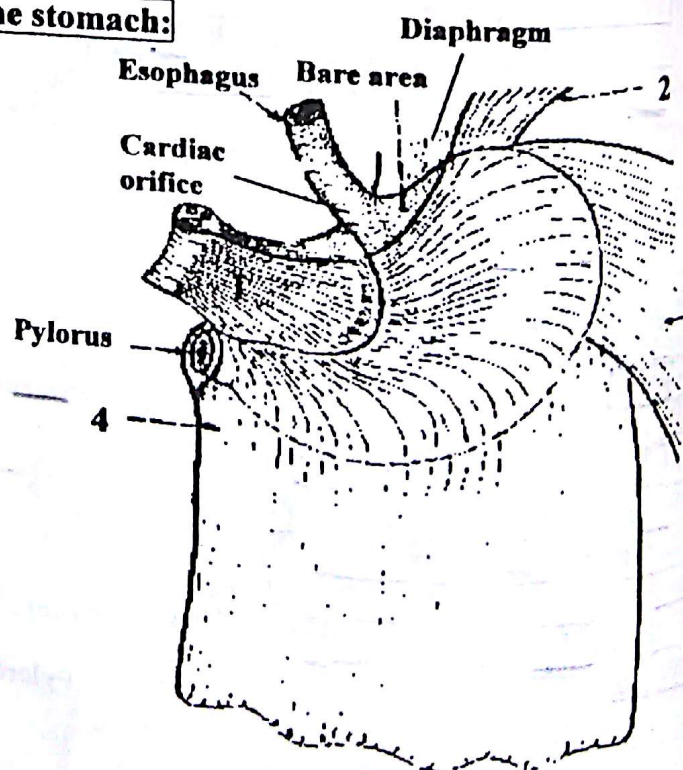
Peritoneal covering and connections of the stomach:

- The stomach is completely covered with peritoneum except for small bare area on its postero-inferior surface which has no peritoneal covering.

This bare area lies close to the cardiac orifice where the stomach is directly related to the left crus of diaphragm.

- The stomach has the following 4 peritoneal folds connected to its curvatures (borders):

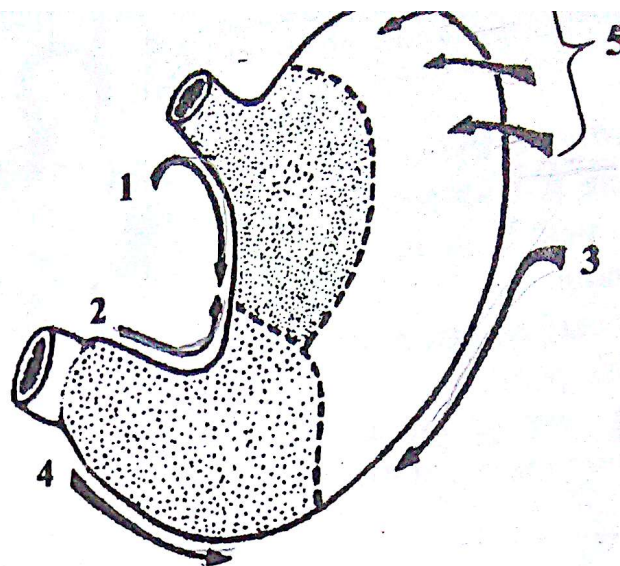
(1) lesser omentum, (2) gastro-phrenic ligament, (3) gastro-splenic ligament and (4) greater omentum.



Blood Supply:

The stomach is supplied by branches of the coeliac artery, being a part of the foregut. These are:

1. Left gastric artery,
2. Right gastric artery,
3. Left gastro-epiploic artery,
4. Right gastro-epiploic artery and
5. Short gastric arteries.



Venous drainage:

By five veins correspond to the arteries (all drain directly or indirectly into the portal vein).

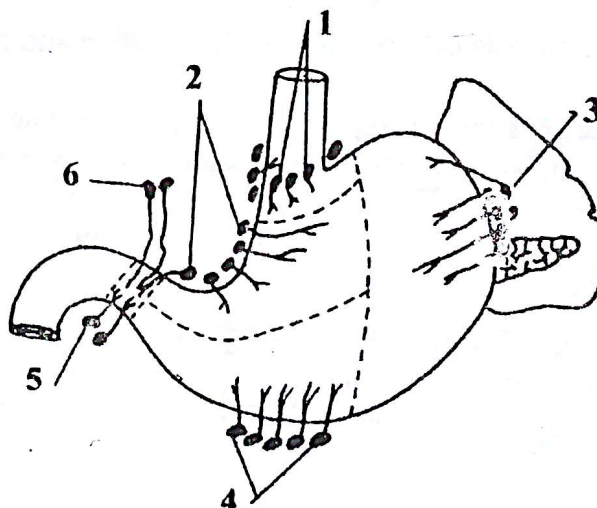
1. Right gastric &	both veins drain into <u>portal vein</u> directly.
2. Left gastric	
3. Short gastric &	
4. Left gastro-epiploic	both veins drain into <u>splenic vein</u> → <u>portal vein</u> .
5. Right gastro-epiploic	drains into <u>superior mesenteric vein</u> → <u>portal vein</u> .

Lymph drainage of stomach :

The stomach drains into:

- (1) the paracardial,
- (2) left gastric,
- (3) pancreatico-splenic,
- (4) right gastro-epiploic,
- (5) pyloric and
- (6) hepatic lymph nodes.

All these nodes drain into coeliac lymph nodes.

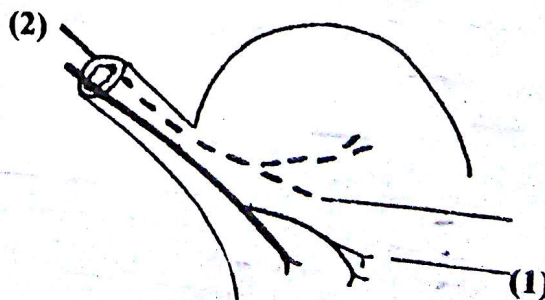


Nerve supply : (para sympathetic & sympathetic)

A. Parasympathetic nerve supply:

It is derived from anterior and posterior gastric nerves.

- (1) Anterior gastric nerve: which runs on the antero-superior surface of the stomach and is composed mainly of the left vagus.
 - (2) Posterior gastric nerve: which runs on the postero-inferior surface of the stomach and is composed mainly of the right vagus.
- The parasympathetic supply is motor to stomach musculature & inhibitory to pyloric sphincter &
 - Secretomotor to gastric glands.



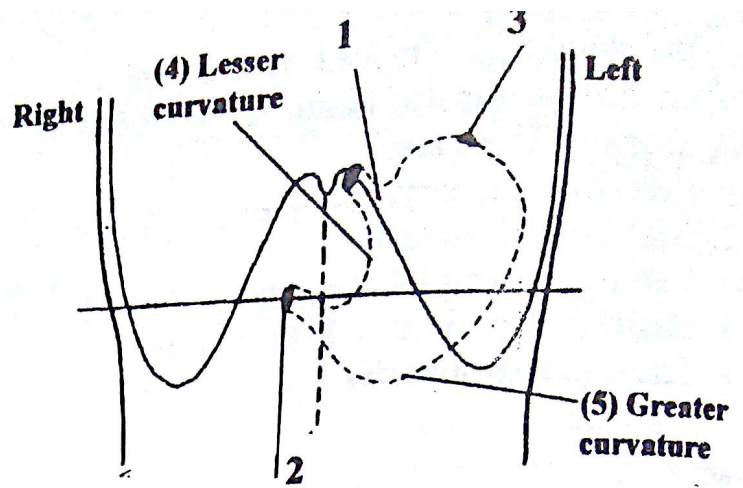
- B. Sympathetic nerve supply which is derived from the coeliac plexus and reaches the stomach through the sympathetic plexuses around the supplying arteries.
- It is inhibitory to the stomach musculature & motor to pyloric sphincter &
- It also vasomotor and carry pain sensations from the stomach.

Surface anatomy of the stomach:

(1) **Cardiac orifice:** lies opposite a point on the left seventh costal cartilage, one inch from its junction with the sternum.

The cardiac orifice lies 4 inches deep to this point.

The average distance between the incisor teeth and the cardiac orifice is 40 cm.



(2) **Pyloric orifice (pylorus):** lies opposite a point on the transpyloric plane half an inch to the right of the median plane.

The average distance between the incisor teeth and the pylorus is 57 cm.

(3) **The fundus:** lies opposite a point on the left fifth intercostal space, 3.5 inches to the left of the median plane (point of the apex of the heart).

(4) **The lesser curvature:** is represented by a curved line with its concavity to the right.

This line connects between the cardiac orifice and pylorus.

(5) **Greater curvature:** is represented by a curved line with its convexity to the left. This line connects between the cardiac orifice, fundus & pylorus.

Small intestine

Divisions:

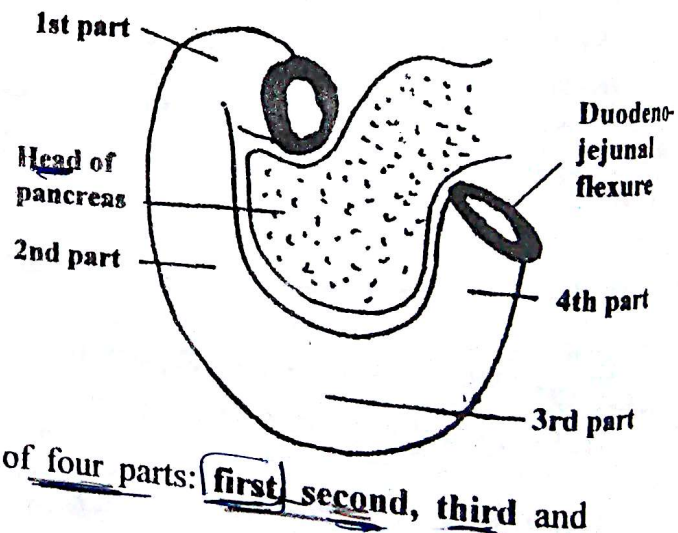
1. **Duodenum:** - Fixed part - 10 inches long.
2. **Jejunum:** Proximal $\frac{2}{5}$ free part - 20 feet long.
3. **Ileum:** distal $\frac{3}{5}$ free part - 20 feet long.

Duodenum

This part is fixed on the posterior abdominal wall and has no mesentery.

It forms a C-shaped curve around the head of pancreas.

Accordingly it is described as being composed of four parts: first, second, third and fourth.



First part: two inches long.

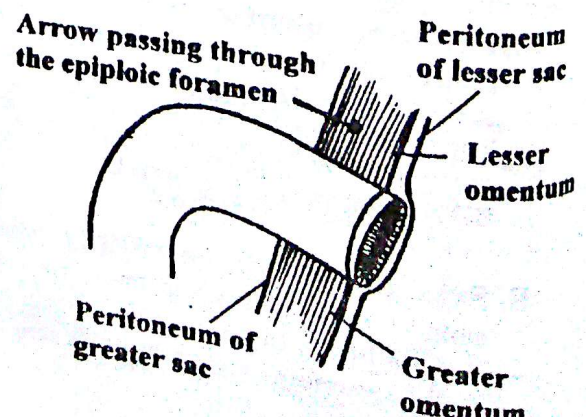
This part is directed upwards, backwards and to the right.

- It begins at the pylorus, at the level of the first lumbar vertebra.
- It ends close to the neck of gall bladder.

The first inch is the only movable part of the duodenum, it is covered anteriorly by peritoneum of the greater sac and posteriorly by peritoneum of the lesser sac.

- It is connected superiorly to the lesser omentum.
- It is connected inferiorly to the greater omentum.

The second inch is fixed because, it is retroperitoneal i.e. covered with peritoneum only anteriorly.



Relations of the 1st part:

Anteriorly:

- First inch: related to quadrate lobe of liver.
- Second inch: related to neck of gall bladder.

Posteriorly:

- First inch: related to neck of pancreas.
- Second inch: bile duct(1), gastroduodenal artery(2) & portal vein(3) (behind the artery and duct).

- Superiorly: opening into the lesser sac.
- Inferiorly: head of pancreas.

Second part: three inches long.

- It descends vertically from the level of the first lumbar to the level of the third lumbar vertebra.
- This part is only partially covered by peritoneum anteriorly.

Relations of the second part:

Anteriorly:

- Its upper part is covered by peritoneum and is related to the duodenal impression of the right lobe of the liver.
- Its middle part is crossed directly by the transverse colon.
- Its lower part is covered by peritoneum and is related to loops of the jejunum.

Posteriorly:

- The 2nd part is related to the front of the right kidney close to its hilum and right renal vessels which separate the duodenum from the right psoas major muscle.

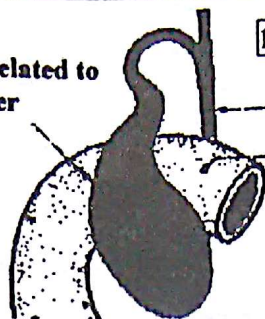
Laterally:

- The right colic flexure and the fat in front of the right kidney.

Medially:

- The head of the pancreas and the bile duct.
- The bile duct opens into the postero-medial aspect of the second part just below its middle.

2nd inch related to gall bladder



1st part - ant. relations

Bile duct (post.)

1st inch related to quadrate lobe of liver

1st part: post.- sup. - inf. relations

2nd inch

Inferiorly the head of pancreas

Superiorly: opening into lesser sac

1st inch related to neck of pancreas

The upper part is related to the duodenal impression of the right lobe of liver

Rt. colic flexure lies lateral to the 2nd part

Transverse colon cross the middle part

The lower part related to coils of jejunum

2nd part - ant. - lat. relations

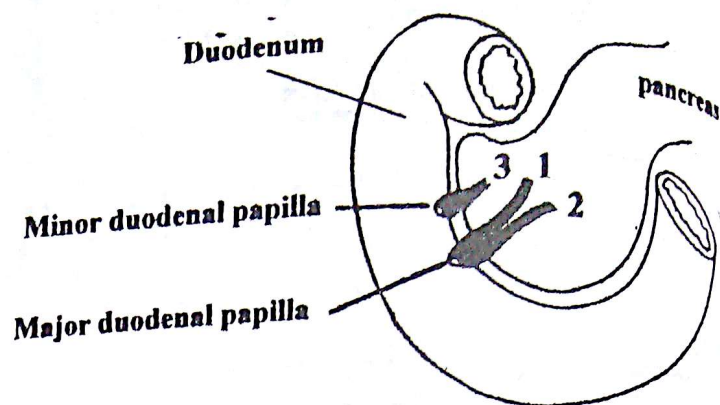
2nd part post. relations

Hilum of Rt. kidney

Rt. kidney

Renal vessels

- The bile duct(1) usually unit with the main pancreatic duct(2), and the two ducts from a dilatation inside the wall of the duodenum which is called the hepato-pancreatic ampulla (ampulla of Vater).
- The ampulla opens into the lumen of the duodenum by a narrow opening which is situated on the summit of a papilla known as the major duodenal papilla.
- The accessory pancreatic duct(3) opens into the second part, about one inch above the major duodenal papilla, on the summit of a smaller papilla known as the minor duodenal papilla.



Third part: four inches long (longest part).

- It lies nearly in a horizontal plane at the level of the third lumbar vertebra.
- It is covered by peritoneum only anteriorly (partial) and inferiorly where it is related to the coils of jejunum.

Relations of the 3rd part:

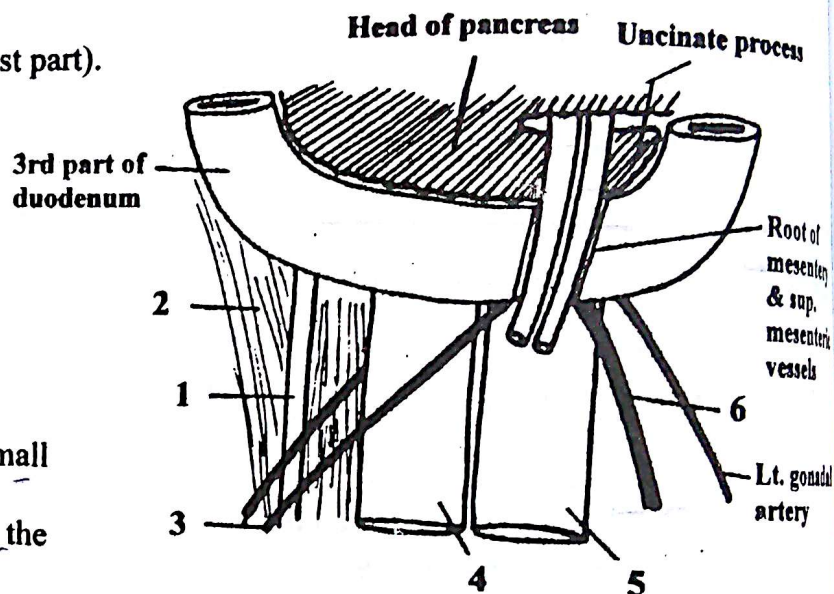
Anteriorly: it is crossed by:

- Root of mesentery of the small intestine.
- Superior mesenteric vessels (in the root of mesentery).

Superiorly: head of pancreas.

Posteriorly: it crosses the following structures from the right to the left side:

- (1) right ureter,
- (2) right psaos major,
- (3) right testicular or ovarian (gonadal) vessels,
- (4) inferior vena cava,
- (5) abdominal aorta and the origin of the inferior mesenteric artery (6).



Fourth part: one inch long (shortest part).

- It ascends from the level of the third to the level of the second lumbar vertebra.
- It ends in the duodeno-jejunal flexure.
- It is covered by peritoneum anteriorly and to the left.

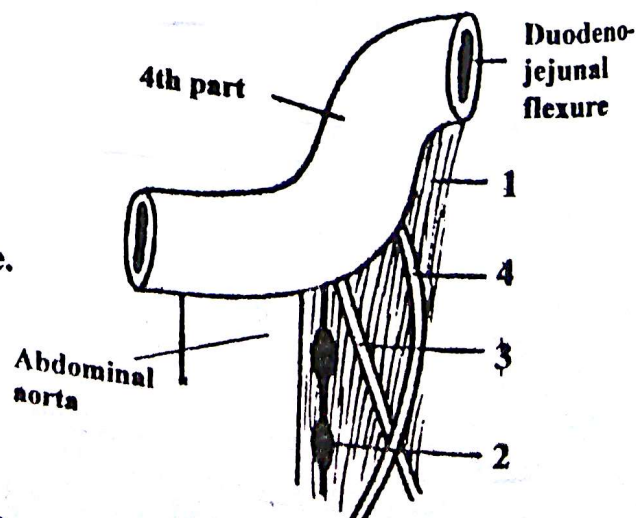
Relations of the 4th part:

Anteriorly: it is related to coils of small intestine.

Posteriorly: it is related to:

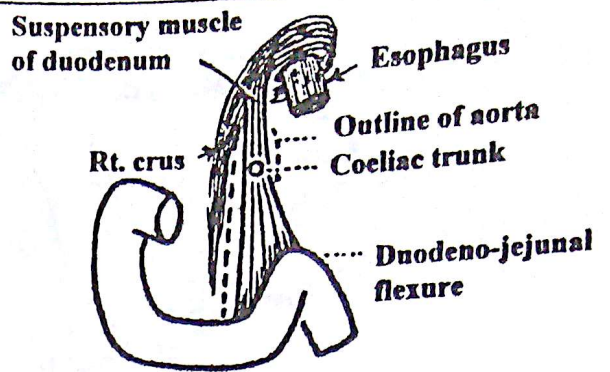
- (1) left psaos major,
- (2) left sympathetic trunk,
- (3) left gonadal vessels and
- (4) inferior mesenteric vein.

Medially: it is related to the abdominal aorta.



*Let :- coils of small intestine
- H of left Kid.*

Suspensory muscle of the duodenum: a fibro-muscular band which connects the right crus of the diaphragm with the duodeno-jejunal flexure and the fourth parts of the duodenum.

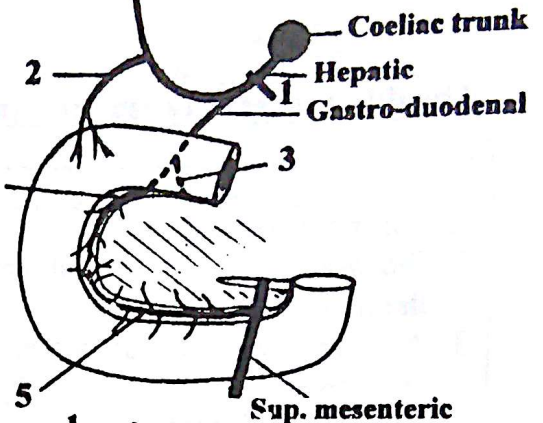


Arterial supply of duodenum:

Being developed from fore and mid guts. The duodenum is supplied by coeliac trunk and superior mesenteric artery.

1. right gastric artery,
 2. supra-duodenal artery,
 3. right gastro-epiploic artery,
 4. superior pancreaticoduodenal artery and
 5. inferior pancreaticoduodenal artery (from superior mesenteric artery).
- (from coeliac trunk)

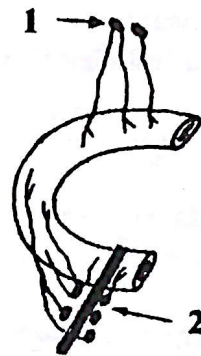
- Venous drainage of duodenum into splenic superior mesenteric and portal veins.



Lymph drainage of duodenum:

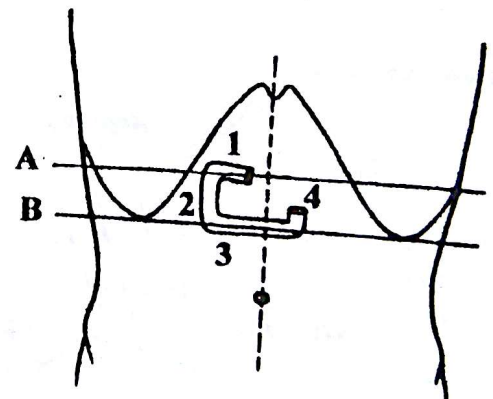
The duodenum drains into:

1. the hepatic and
2. superior mesenteric lymph nodes.



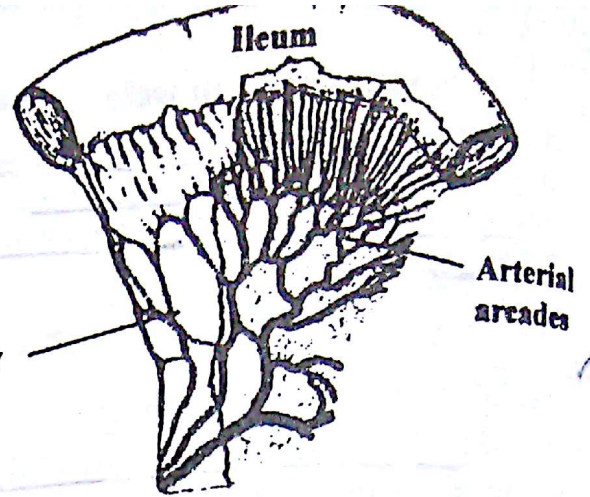
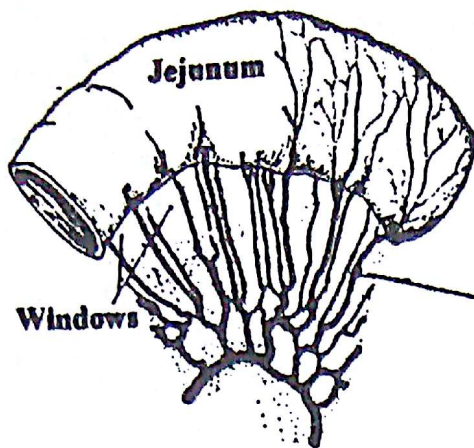
Surface anatomy:

1. **First part:** From the pylorus opposite a point on the transpyloric plane (A) half an inch to the right of the median plane (level of first lumbar vertebra) draw a broad line to the right of the median plane upwards for two inches.
2. **Second part:** Continue the line vertically downwards from the transpyloric plane (level of first lumbar vertebra) to the subcostal plane (B) (level of third lumbar vertebra).
3. **Third part:** Continue the line horizontally from the right to the left with a slight upward inclination on the subcostal plane (B) (level of third lumbar vertebra) for four inches.
4. **Fourth part:** Continue the line upwards for one inch to a point opposite the duodenojejunal flexure (level of second lumbar vertebra).



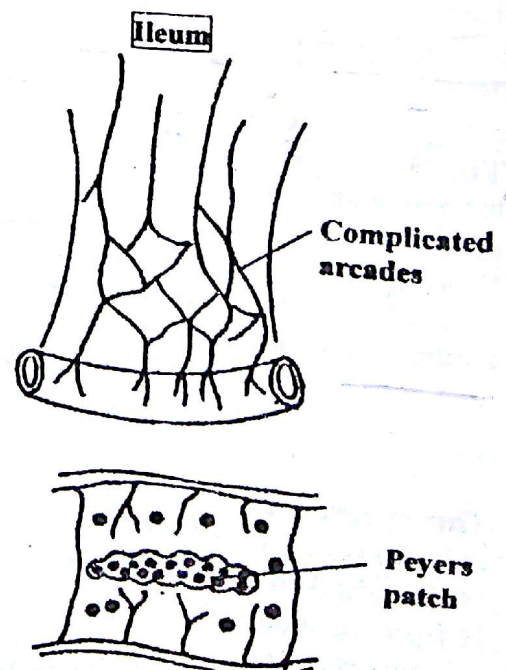
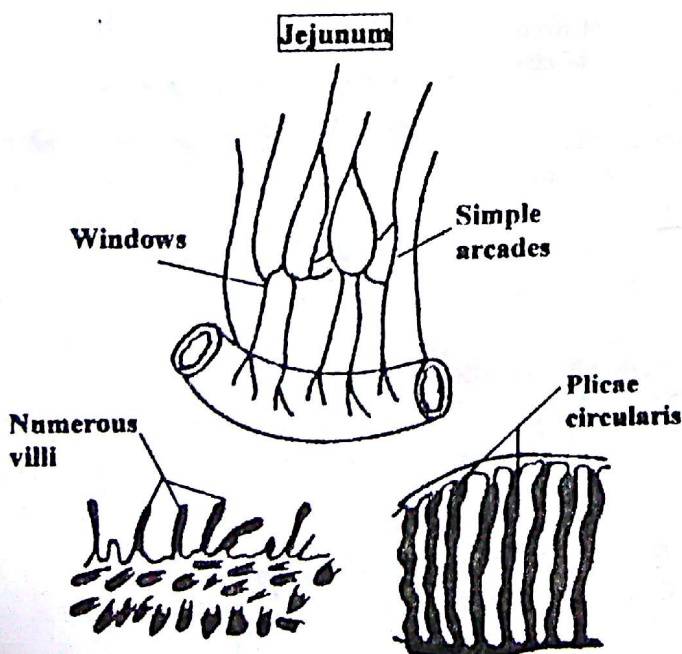
Free part of the small intestine (Jejunum and ileum)

- This is about 20 feet long.
 - It is almost completely covered with peritoneum.
 - It extends from the duodeno-jejunal flexure to the ileo-caecal junction.
 - It forms a number of loops which are attached to the posterior abdominal wall by the mesentery.
- The proximal two-fifths form the jejunum while the distal three fifths form the ileum.

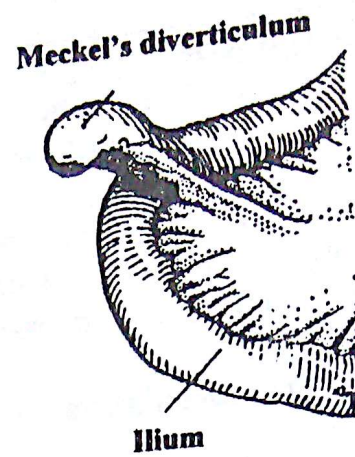
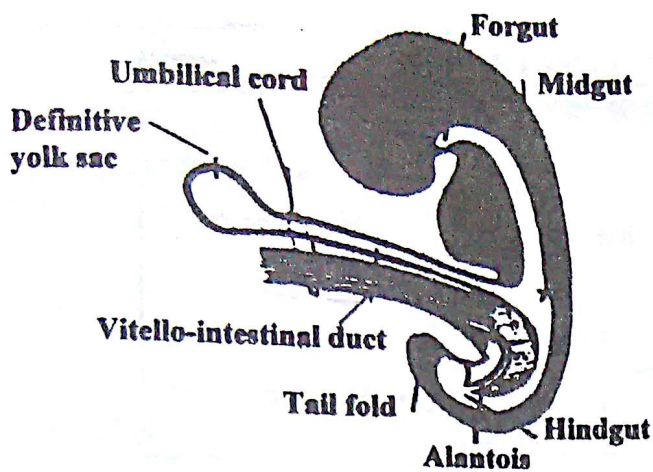


The differences between the jejunum and ileum are:

Jejunum	Ileum
1. Proximal two-fifths.	1. Distal three-fifths.
2. Simple system of arterial arcades in the mesentery.	2. Complicated system of arterial arcades in the mesentery.
3. A small amount of mesenteric fat (windows).	3. A great amount of mesenteric fat (no windows).
4. Larger in diameter.	4. Smaller in diameter.
5. No lymphoid follicles.	5. Many solitary and aggregated lymphoid follicles. The aggregated follicles (Peyer's patches) lie in the ante mesenteric border of the ileum.
6. Plicae circularis (circular folds of the mucosa) are larger and more numerous.	6. Plicae circularis are small and few.
7. Villi are larger and more numerous.	7. Villi are smaller and less numerous.



Diverticulum ilei (Meckel's diverticulum):



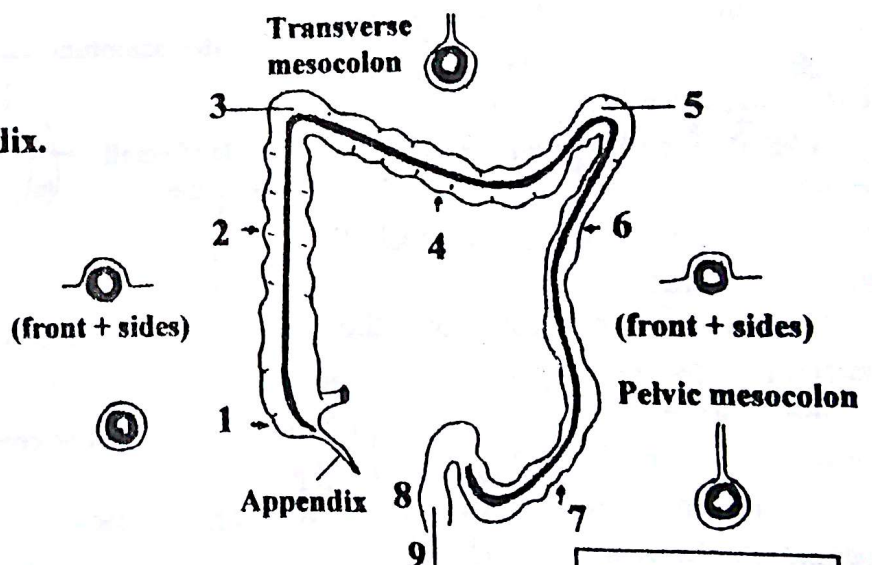
- It is present in 2% of people and is 5cm long.
- It projects from the free border of the ileum, about 1 meter above the ileo-caecal valve.
- It represents the proximal part of the vitello-intestinal duct of the foetus.
- It may be free in the abdomen, or may be connected to the umbilicus by a fibrous cord which is the remains of the distal part of the vitello-intestinal duct.
- It has surgical significance because its inflammation in children (Meckel's diverticulitis) may be misdiagnosed as appendicitis.

LARGE INTESTINE

It begins at the end of the ileum and terminates at the anal orifice.
It is about 5 feet long.

Divisions of the large intestine:

- (1) Caecum and vermiform appendix.
- (2) Ascending colon.
- (3) Right colic (hepatic) flexure.
- (4) Transverse colon.
- (5) Left colic (splenic) flexure.
- (6) Descending colon.
- (7) Pelvic (sigmoid) colon.
- (8) Rectum.
- (9) Anal canal.

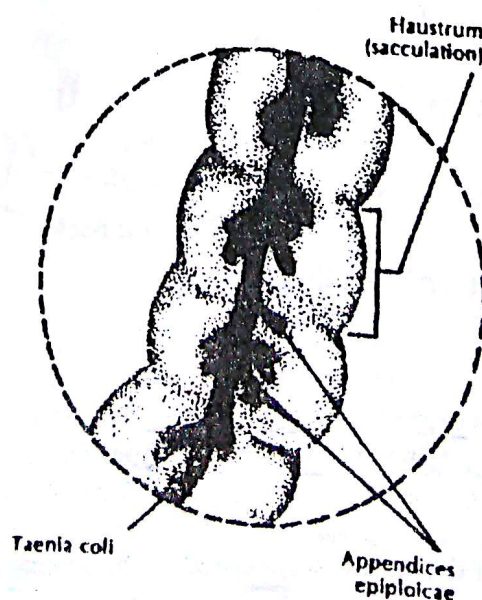


Appendices epiploicae are small peritoneal sacs filled with fat attached to large intestine.

Taenia coli are 3 longitudinal muscle bands present in the wall of the large intestine.

The 3 bands converge to the base of the appendix.

Sacculations (haustrations) present in the large intestine because the taenia coli is shorter than the length of large intestine causing puckering of its wall.



Characteristic of large intestine

Differences between the large and small intestine:

Large intestine	Small intestine
1. <i>Appendices epiploicae</i> are scattered over its surface. These are peritoneal projections filled with fat.	1. No <i>appendices epiploicae</i> .
2. <i>Taeniae coli</i> are present. These are three longitudinal bands which represent the longitudinal muscle layer.	2. No <i>taeniae coli</i> .
3. The wall presents sacculations or haustrations .	3. The wall is smooth, and no sacculations are seen.

Caecum

- The caecum lies in the right iliac fossa.
- It is a blind pouch which is continuous above with ascending colon.
- The ileum opens into the large intestine at the junction between the caecum and ascending colon.
- The vermiform appendix opens into the postero-medial aspect of the caecum about one inch below the ileo-caecal valve.
- The caecum is usually covered by peritoneum completely, except for, sometimes, the upper part of its posterior wall. As a result, it enjoys a considerable amount of movement.

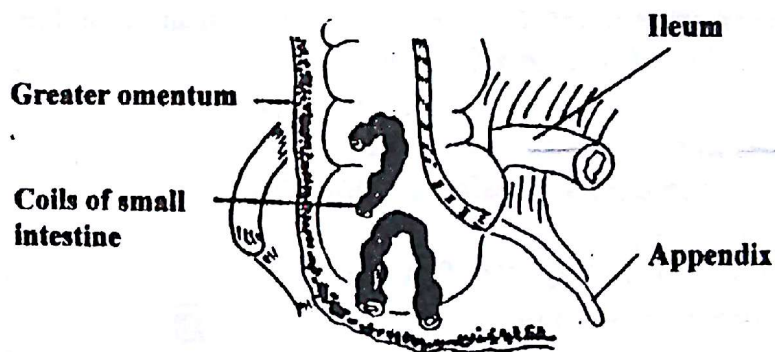
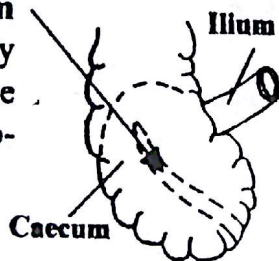
Relations of the caecum:

Anteriorly and laterally: the caecum is related to the anterior abdominal wall; separated from it by coils of small intestine and the greater omentum.

Medially: it is related to coil of small intestine.

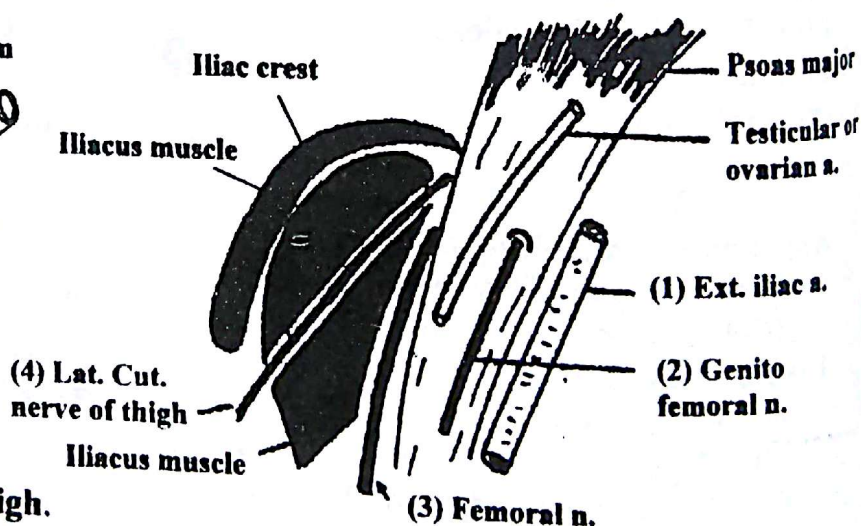
Posteriorly: it rests on the iliacus and psoas major.

The vermiform appendix usually lies behind the caecum in the retro-caecal recess.



The caecum also rests on:

- (1) the external iliac artery,
- (2) genito-femoral nerve,
- (3) femoral nerve and
- (4) lateral cutaneous nerve of the thigh.

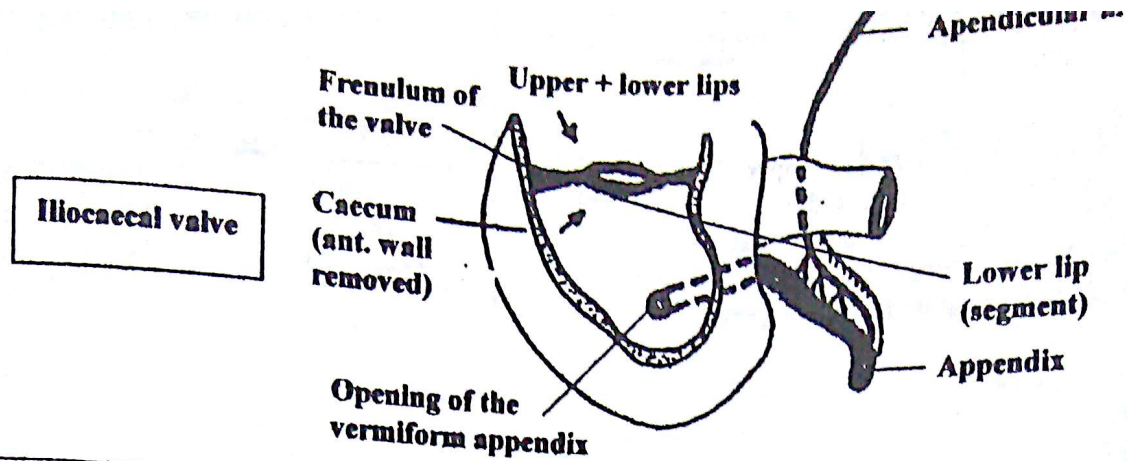


Ileocaecal valve:

The termination of the ileum projects into the lumen of the colon to form the ileo-caecal valve. The valve is composed of two lips or segments, an upper and a lower segments.

The two segments meet on each side in a ridge of mucous membrane which is known as the frenulum of the valve.

The circular muscle layer of the ileum is thickened in the region of the valve to form a sort of a sphincter.



Arterial supply of the caecum:

The caecum is supplied by the anterior and posterior caecal arteries which are branches of iliocolic artery which is branches of superior mesenteric artery.

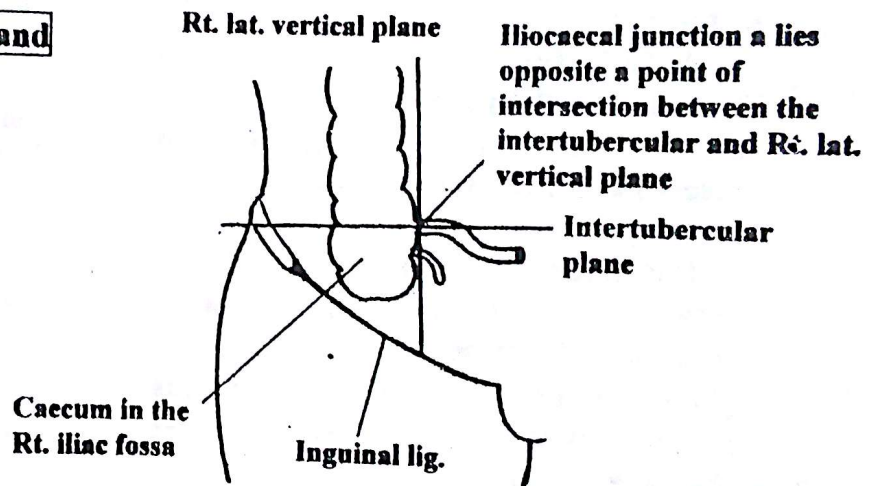
Venous drainage of caecum: by the anterior and posterior caecal veins into the ileocolic vein.

Lymphatic drainage of caecum: the caecum drains into the ileocolic lymphatic nodes.

Surface anatomy of the caecum and iliocaecal junction:

The caecum lies opposite a triangular area which is bound by the right lateral plane, intertubercular plane and the lateral half of inguinal ligament.

This area indicate that the caecum occupies the right iliac fossa.

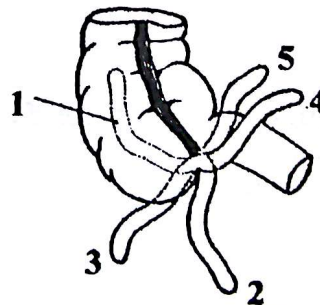


Vermiform appendix

This is a very narrow worm-like tube which opens into the postero-medial aspect of the caecum about one inch below the ileo-caecal valve.

The vermiform appendix may acquire one of the following positions:

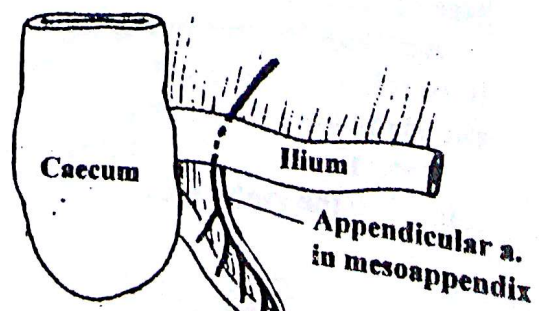
- (1) Retro-caecal: in 74% of people.
- (2) Pelvic: in 21% of people.
- (3) Subcaecal: in 3.5%.
- (4) Preilel: 1%.
- (5) Postileal: in 0.5%.



Arterial supply:

by the appendicular artery.

This is a branch of the ileocolic artery which descends behind the terminal part of the ileum and then in the free margin of the mesoappendix, giving branches to the appendix along its course.

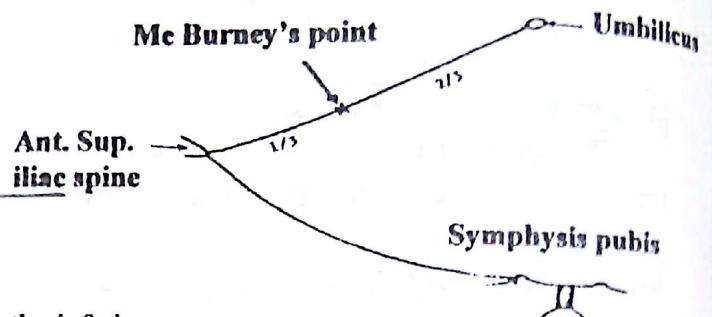
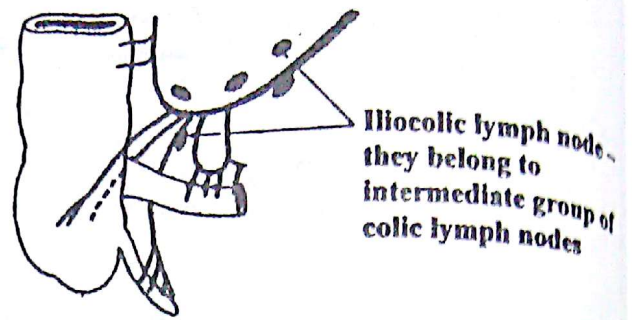


Venous drainage: by the appendicular vein which runs along the artery to join the ileocolic vein.

Lymphatic drainage: the appendix drains into the ileocolic lymph nodes.
Some vessels are interrupted in the appendicular lymph node which is a small lymph node lying in the mesoappendix.

Surface anatomy:

Mc Burney's point: this point indicates the surface marking of the base of the appendix. It is a point at the junction between the lateral third and medial two-thirds of a line joining the right anterior superior iliac spine with the umbilicus.



Ascending colon

This begins at the upper end of the caecum to the inferior surface of the liver, where it forms the right colic flexure.

It is covered by peritoneum on the front and sides:

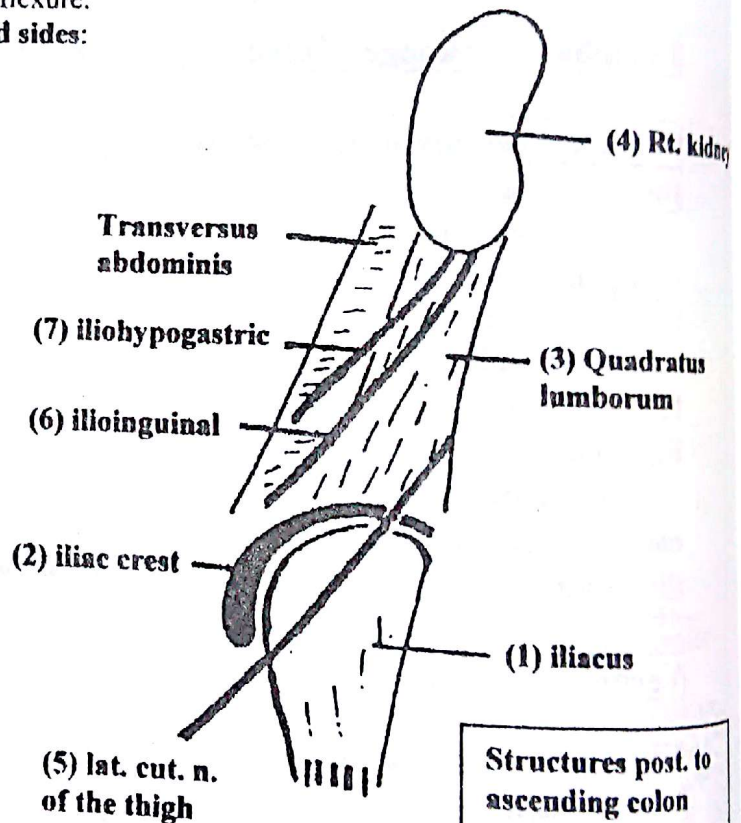
Relations:

Anteriorly: it is related to the anterior abdominal wall from which the colon is separated by coils of small intestine and the greater omentum.

Posteriorly, it has no peritoneal covering; and rests on the following structures from below upwards:

(1) iliacus, (2) iliac crest, (3) quadratus lumborum and lastly the fat in front of the (4) right kidney.

The colon is separated from these structures by the (5) lateral cutaneous nerve of the thigh and, sometimes, the (6) Ilio-inguinal and (7) iliohypogastric nerves.



Structures post. to ascending colon

Right colic flexure (hepatic flexure)

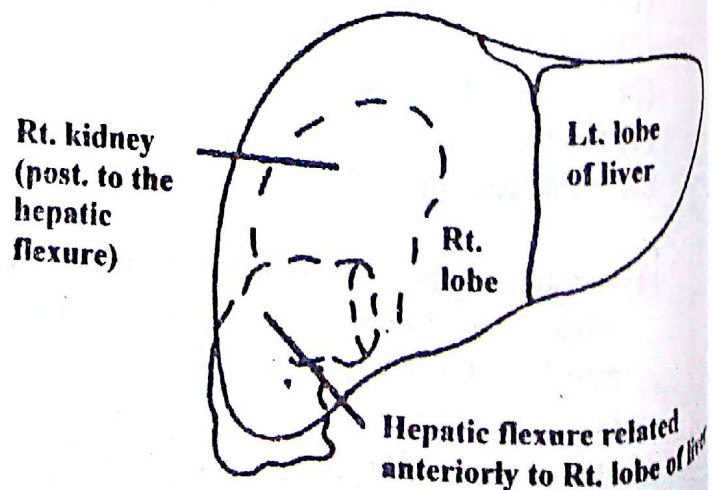
This part forms the region of junction between the ascending and transverse colon.

It is covered by peritoneum except posteriorly.

Relations:

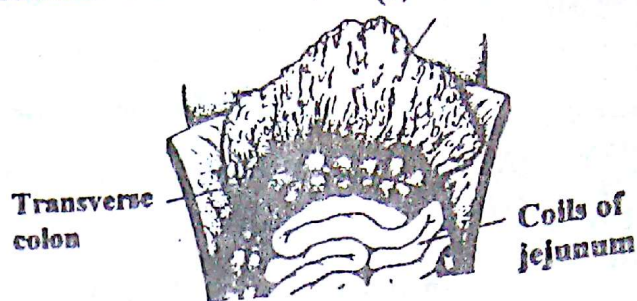
Anteriorly, superiorly and laterally it is related to the colic impression of the right lobe of the liver.

Postero-medially, it is directly related to the right kidney.



Transverse colon

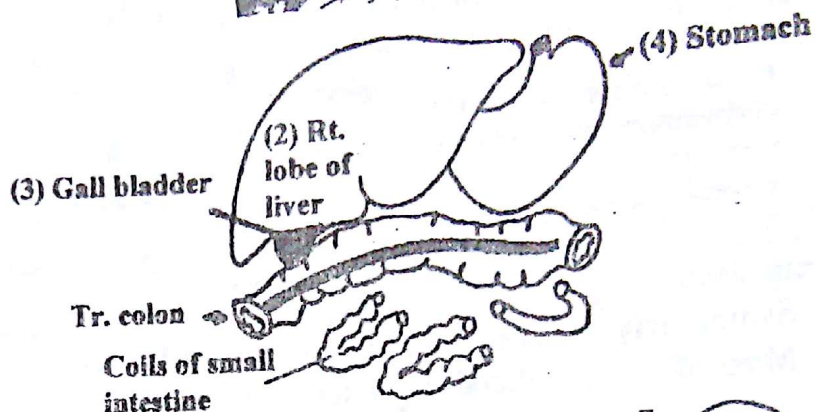
The transverse colon is 50 cm long and begins from the right flexure in the right hypochondrium to the left flexure in the left hypochondrium.



Relations:

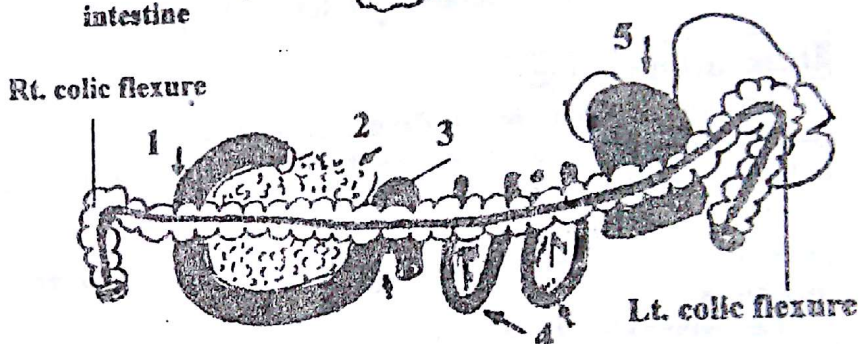
Anteriorly:

- (1) Greater omentum.
- (2) Right lobe of liver.
- (3) Body of the gall bladder.
- (4) Stomach.

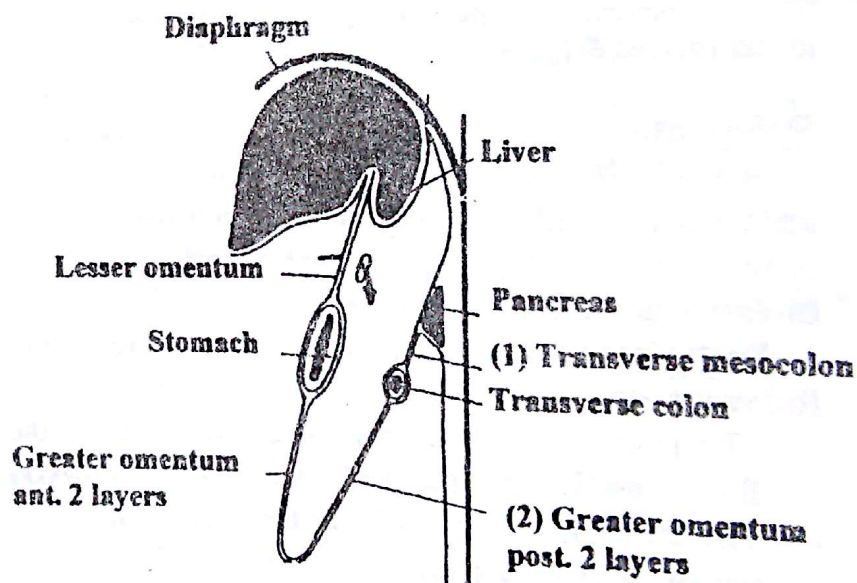


Posteriorly: as follows from right to left:

- (1) 2nd part of duodenum.
- (2) Head of pancreas.
- (3) Duodeno-jejunal flexure.
- (4) Coils of small intestine.
- (5) Left kidney.

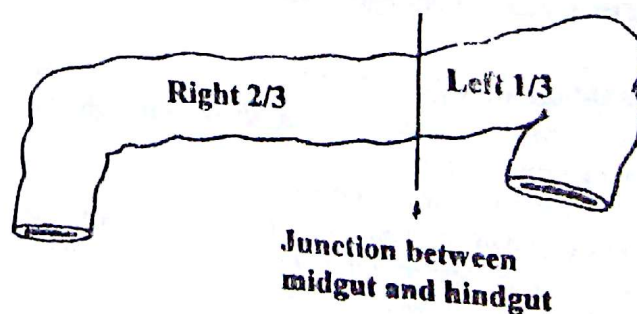


- The transverse colon is almost completely covered with peritoneum (except the part related to the duodenum and head of pancreas, in the colon is covered with peritoneum only anteriorly and on the 2 sides).
- The transverse colon is mobile. It is suspended superiorly from the posterior abdominal wall by the transverse mesocolon (1) (except the part related to the duodenum and head of pancreas, where the colon lies directly on them). It is attached inferiorly to the posterior 2 layers of the greater omentum (2).



Arterial supply:

1. Right 2/3: are supplied by right colic and middle colic branches of the superior mesenteric artery (derives from the midgut).
2. Left 1/3 is supplied by the upper left colic branch of the inferior mesenteric artery (derived from the hindgut).



Venous drainage: into the left colic and upper sigmoid veins (tributaries of the inferior mesenteric vein).

Left colic flexure (splenic flexure)

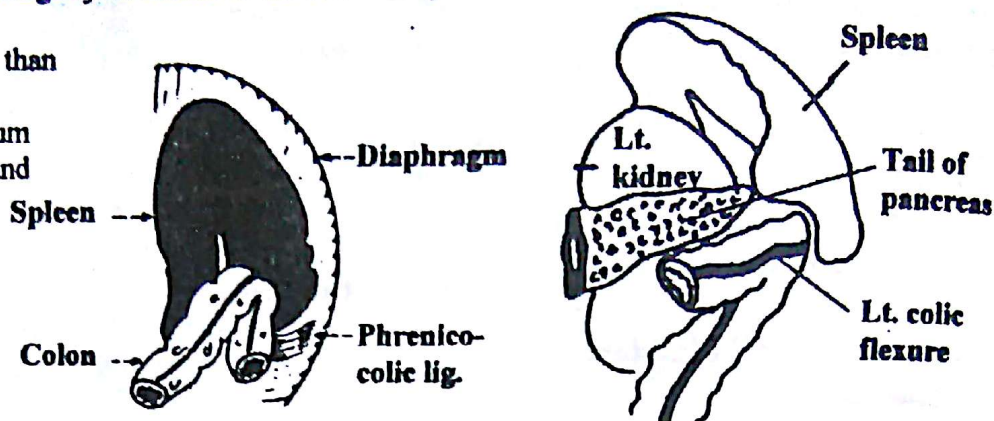
This part forms the region of junction between the transverse descending colon, this flexure is more acute than the right flexure.

- It lies directly on the diaphragm just lateral to the left kidney i.e. it is farther from the median plane than the right flexure.

Also, it lies at a higher level than the right flexure.

It is covered by peritoneum anteriorly, superiorly and laterally.

- It is connected to the diaphragm by a fold of peritoneum known as the phrenico-colic ligament.



Relations:

Superiorly, it is related to the lateral end of the spleen and the tail of pancreas.
Medially, it is related to the left kidney.

Descending colon

This begins from the left flexure and ends at the inlet of the pelvis where it joins the pelvic colon (sigmoid colon).

It is covered by peritoneum on the front and sides.

On each side of the colon there is longitudinal peritoneal gutter (medial & lateral).

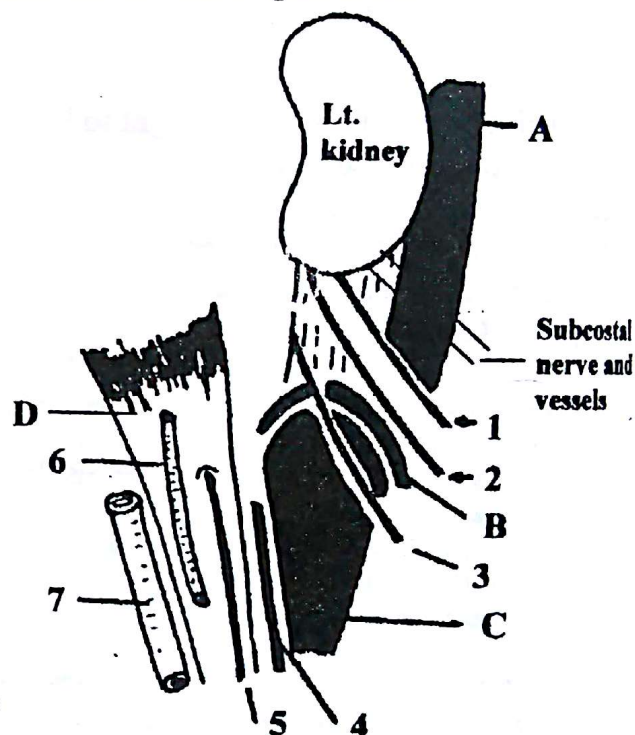


Relations:

Anteriorly, it is related to the anterior abdominal wall, from which it is partially separated by coils of small intestine and the greater omentum.

Posteriorly, it has no peritoneal covering, and rests on the following structures from above downwards:

- The lower and lateral part of the left kidney, the quadratus lumborum(A), the iliac crest(B), the iliocostus(C) and psoas major(D).
- The colon is separated from these structures by the subcostal vessels, subcostal nerve, ilio-hypogastric nerve(1), ilio-inguinal nerve(2), lateral cutaneous nerve of the thigh(3), femoral nerve(4), genito-femoral nerve(5), testicular or ovarian vessels(6) and the external iliac artery(7).

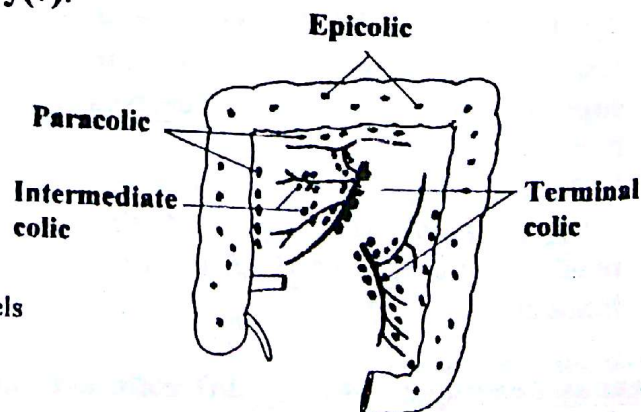


Lymphatic drainage of colon:

The lymphatics of the colon drain through the following colic lymph nodes:

- Epicolic lymph nodes:** on the wall of colon.
- Para colic lymph nodes:** along the medial border of the ascending & descending colon and the mesenteric border of the transverse and sigmoid colon.
- Intermediate colic lymph nodes:** along the colic vessels (right colic, ilio-colic, middle colic, left colic ...).
- Terminal colic lymph nodes:** along the superior and inferior mesenteric vessels.

Efferent lymphatics of these node drain into 2 intestinal lymph trunk then → into the cisterna chyli.



BLOOD VESSELS OF THE GUT

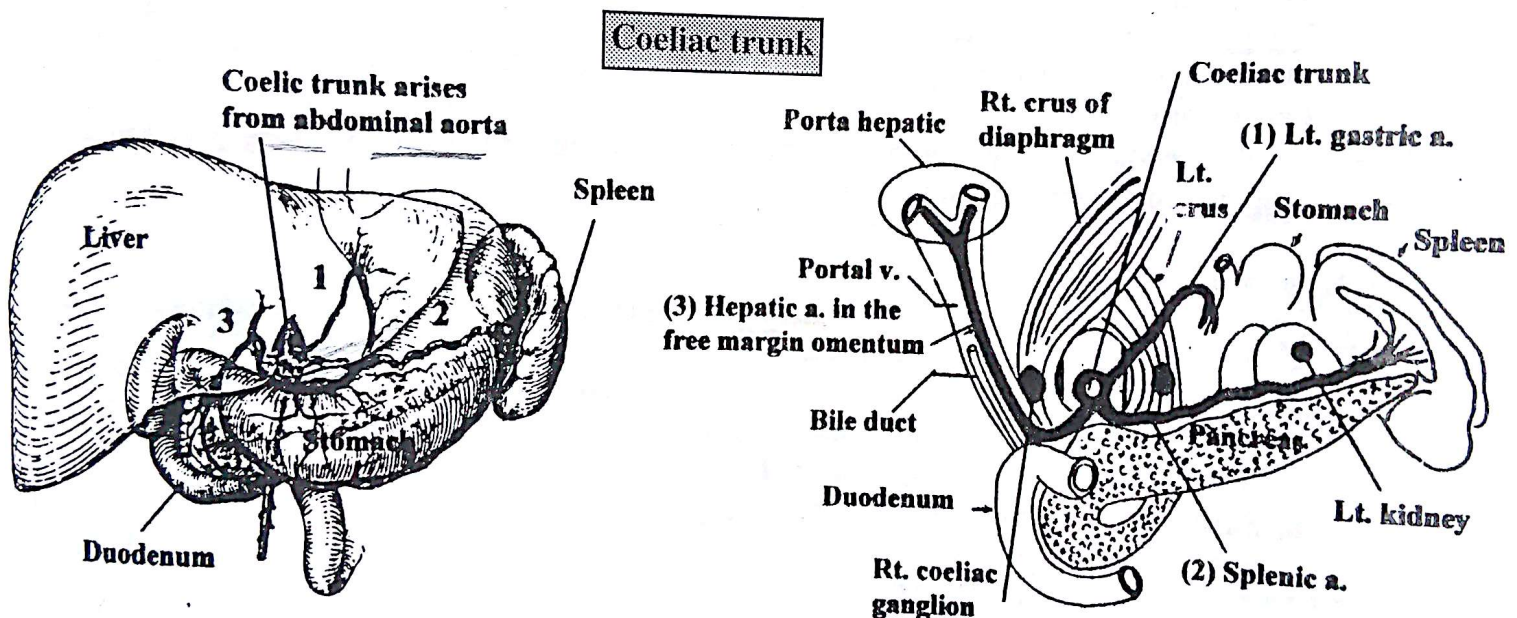
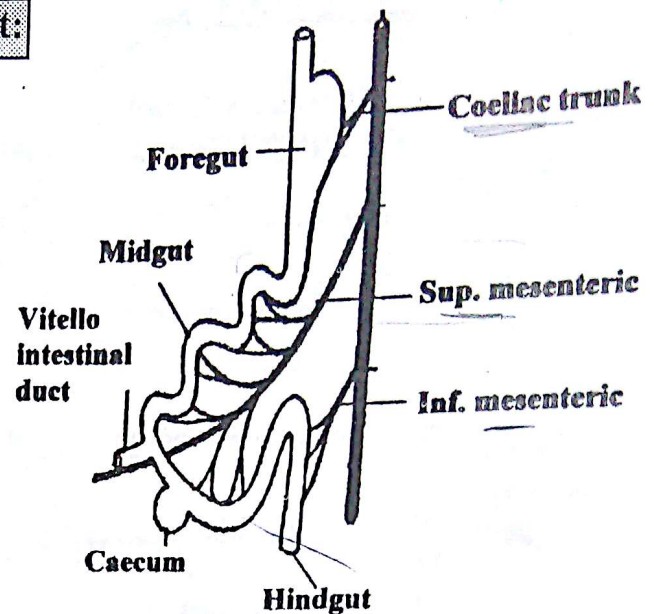
Arteries of the gut in relation to its development:

The gut is divided embryologically into 3 parts: foregut, midgut and hindgut.

1. Foregut: includes the esophagus, stomach and upper 1/2 of the duodenum. It is supplied by the coeliac trunk.

2. Midgut: includes the lower 1/2 of the duodenum, jejunum, ileum, ascending colon and right 2/3 of transverse colon. It is supplied by the superior mesenteric artery.

3. Hindgut: includes the left 1/3 of the transverse colon, descending colon, sigmoid colon, rectum and upper 1/2 of anal canal. It is supplied by the inferior mesenteric artery.



Origin: it is a wide short trunk (1 cm long) from the front of the abdominal aorta at the level of the upper part of the body of the first lumbar vertebra.

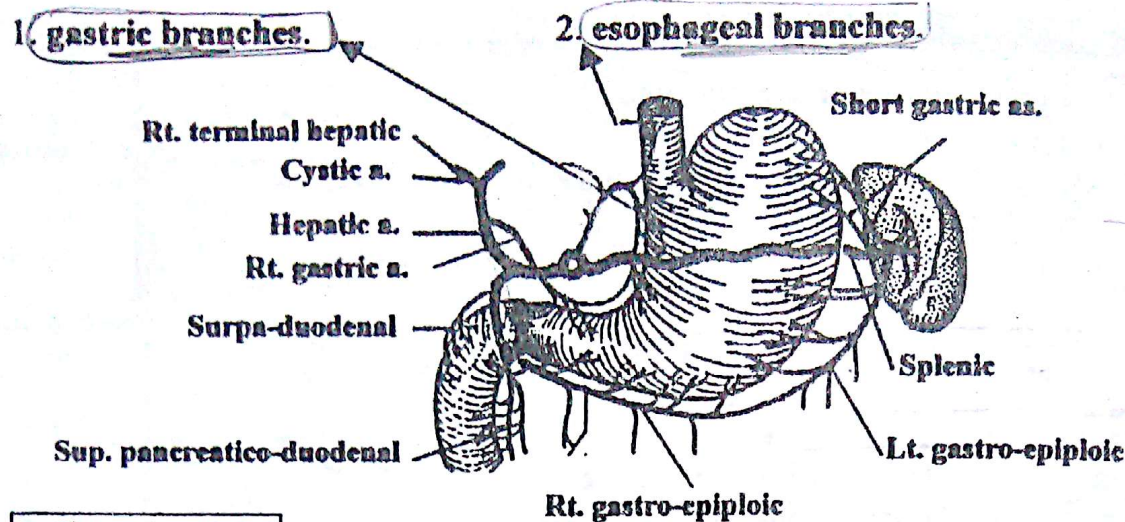
- It lies behind the lesser sac.
- It is surrounded by the coeliac plexus of nerves, and has on each side a coeliac ganglion and one crus of diaphragm.

Immediately above the pancreas the coeliac artery divides into 3 terminal branches: (1) the left gastric, (2) hepatic and (3) splenic arteries.

1. Left gastric artery

- This is the smallest branch of the coeliac artery.
- It passes upwards and to the left behind the posterior wall of the lesser sac.
- At the lower end of esophagus, it curves forwards and downwards to run along the lesser curvature of the stomach between the two layers of the lesser omentum.
- It ends by anastomosing with the right gastric artery.

Branches of the left gastric artery:



2. Hepatic artery

This branch is slightly larger than the left gastric artery.

- It passes forwards and to the right to the upper surface of the first part of the duodenum.
- It curves upwards and ascends between the two layers of the lesser omentum to the porta hepatis where it divides into two terminal branches, the right and left hepatic arteries.
- As it ascends in the free margin of the lesser omentum it lies in front of the portal vein and to the left side of the bile duct.

Branches:

1. Gastro-duodenal artery: which descends behind the first part of the duodenum where it divides into two branches:

a. Right gastro-epiploic artery: which runs along the greater curvature of the stomach, between the anterior two layers of the greater omentum.

It ends by anastomosing with the left gastro-epiploic artery.

b. Superior pancreatico-duodenal artery: which runs between the duodenum and the head of pancreas.

It gives branches to the duodenum and head of pancreas, and ends by anastomosing with the inferior pancreatico-duodenal artery.

2. Right gastric artery: which runs along the lesser curvature of the stomach and anastomoses with the left gastric artery.

3. Supra-duodenal artery: which is a small branch that supplies the upper part of the first part of the duodenum.

4. Right terminal hepatic branch: which enters into the right lobe of the liver.

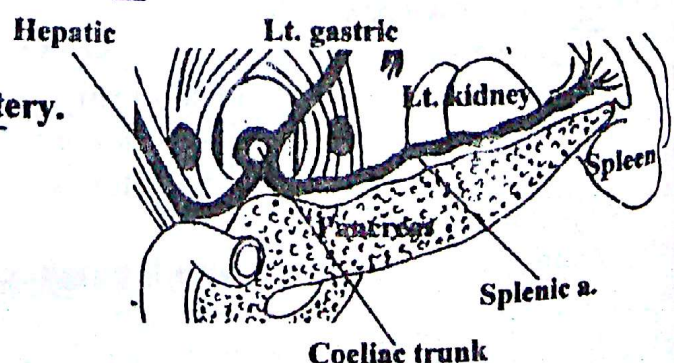
5. Left terminal hepatic branch: which enters into the left lobe of the liver.

6. Cystic artery: which is a small but important artery that arises from the right terminal hepatic artery to supply the gall bladder.

3. Splenic artery

This is largest branch of the coeliac artery.

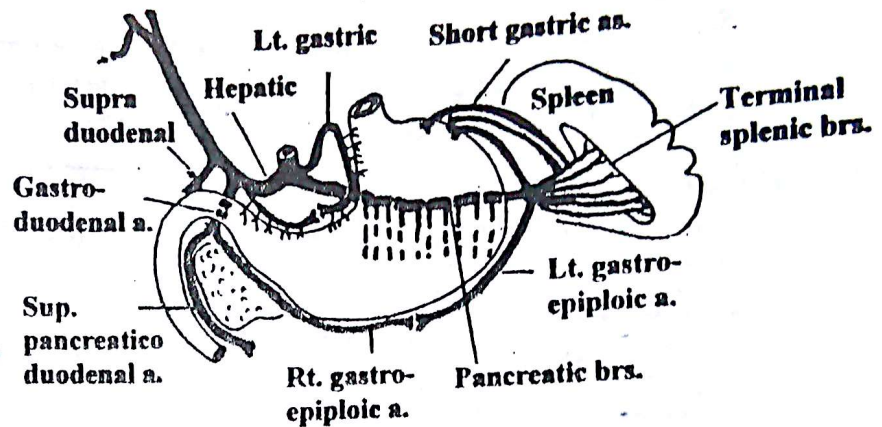
- It runs horizontally following a tortuous course along the upper border of the pancreas, behind the posterior wall of the lesser sac.



- The lesser sac separates the splenic artery from the back of the stomach.
- It enters into the lienorenal ligament where it gives five or six terminal splenic branches enter into the hilum of the spleen.

Branches:

1. **Pancreatic branches:** small and numerous branches which arise from the splenic artery as it runs along the upper border of the pancreas.
2. **Short gastric arteries:** five to seven branches that arise from end from the splenic artery or its terminal branches and pass through the gastro-splenic ligament to reach the fundus of the stomach.
3. **Left gastro-epiploic artery:** which arises from the end of the splenic artery or one of its terminal branches. It runs along the greater curvature of the stomach and ends by anastomosing with the right gastro-epiploic artery.
4. **Terminal splenic branches:** five to six branches that enter into the spleen through its hilum.

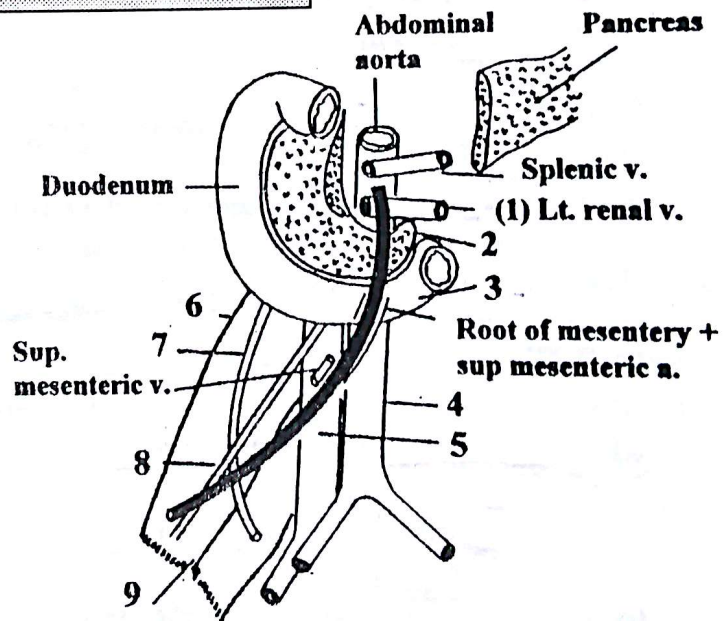


SUPERIOR MESENTERIC ARTERY

Origin: from the front of the abdominal aorta at the level of the lower part of the body of the first lumbar vertebra.

Course and relation

- At its origin the artery lies behind the body of pancreas.
- Then, it appears at the lower border of pancreas and runs through the root of the mesentery into the right iliac fossa where it terminates.
- During its course it describes a gentle curve with its concavity towards the right side.
- The superior mesenteric vein lies close to its right side, i. e. in its concavity. The splenic vein crosses in front of the aorta above the origin of the superior mesenteric artery.
- While the left renal vein crosses in front of the aorta below the origin of the artery. The artery runs in front of the following structures in succession:
 - (1) The left renal vein,
 - (2) the uncinat process of pancreas,
 - (3) the third part of the duodenum,
 - (4) the abdominal aorta,
 - (5) the inferior vena cava,
 - (6) the right psoas major,
 - (7) right ureter,
 - (8) right testicular or ovarian vessels and
 - (9) the right genito-femoral nerve.



Branches of the superior mesenteric artery:

(1) Jejunal and ileal branches: 12-15 in number.

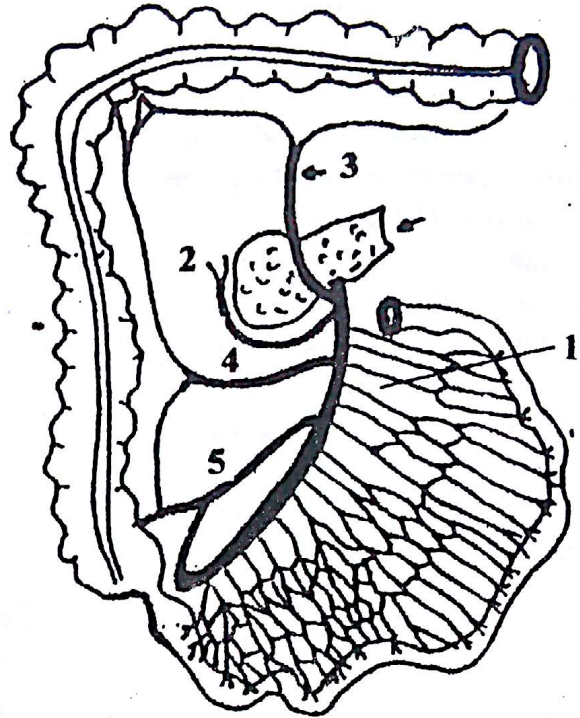
They arise from the convex left side of the artery, and run between the two layers of the mesentery.

- They divide into branches which anastomose with each other to form a series of arterial arcades.
- The arcades are simple in the jejunum and complicated in the ileum.

(2) Inferior pancreatico-duodenal artery runs in the concavity of the duodenum. It gives branches to the duodenum and head of pancreas, and anastomoses with the superior pancreatico-duodenal artery.

(3) Middle colic artery: passes through the transverse mesocolon, where it divides into right and left branches.

- The right branch anastomoses with the ascending branch of the right colic artery.
- The left branch anastomoses with the ascending branch of the superior left colic artery (left colic artery).
- Both branches supply the transverse colon.



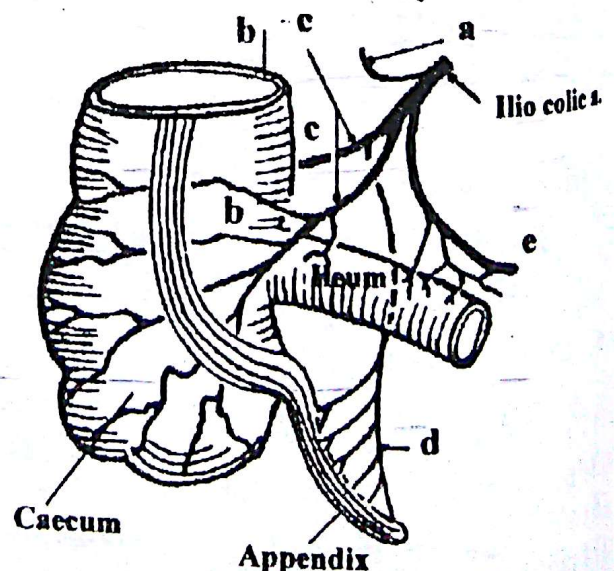
(4) Right colic artery: divides into ascending and descending branches.

The ascending branches.

- The ascending anastomoses with the right branch of the middle colic artery.
 - The descending branch anastomoses with the ascending branch of the ileo-colic artery.
- The two branches supply the upper two-thirds of the ascending colon and the right colic flexure.

(5) Ileo-colic artery gives the following branches:

- Ascending branch, which supplies the lower part of the ascending colon and anastomoses with the descending branch of the right colic artery.
- Anterior caecal artery: to the front of the caecum.
- Posterior caecal artery: to the back of the caecum.
- Appendicular artery: which passes behind the terminal part of the ileum to the mesoappendix, where it gives branches to the vermiform appendix.
- Ileal branches: supply the terminal part of the ileum and anastomose with the end of the superior mesenteric artery.

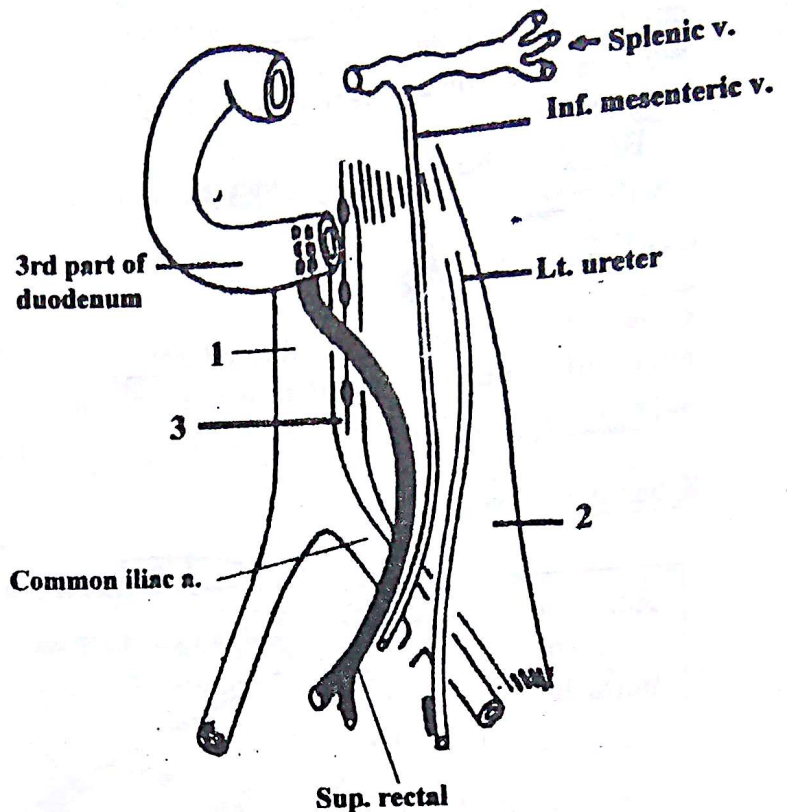


INFERIOR MESENTERIC ARTERY

Origin: from the front of the abdominal aorta at the level of the third lumbar vertebra.

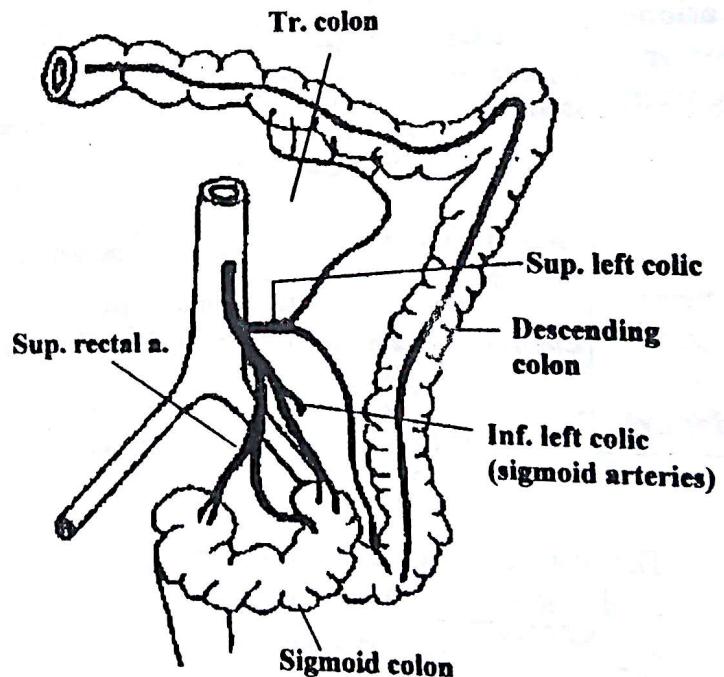
Course and relations:

- At its origin the artery is covered with the third part of the duodenum.
- Then, it descends behind the peritoneum of the posterior abdominal wall.
- As it descends, the artery inclines to the left side.
- At first it lies on the abdominal aorta(1).
- Then, it lies on the left side of the aorta, in front of the left psoas major(2) and the left sympathetic trunk(3).
- The inferior mesenteric vein and the left ureter lie on the lateral side (left side) of the lower part of the artery.
- The artery enters the pelvis by crossing the middle of the left common iliac artery, where it continues as the superior rectal artery.



Branches of the inferior mesenteric:

1. **Superior left colic (left colic) artery:** divides into ascending and descending branches.
 - The ascending branch anastomoses with the left branch of the middle colic artery.
 - The descending branch anastomoses with the upper one of the inferior left colic (sigmoid) arteries.
 - The superior left colic artery supplies the left third of the transverse colon, left colic flexure and the upper part of the descending colon.



2. **Inferior left colic (sigmoid) arteries:** two or three branches which anastomose with each other.

- They anastomose above with the descending branch of the superior left colic artery, and below with the superior rectal artery.
- The sigmoid arteries supply the lower part of the descending colon and the sigmoid colon.

3. **Superior rectal artery:**

- This is the continuation of the inferior mesenteric artery.
- It begins at the middle of the left common iliac artery and descends through the pelvic mesocolon, to reach the rectum.

THE PORTAL VENOUS SYSTEM

This system is formed by the veins which carry blood from the stomach, small intestine and large intestine, as well as the spleen, pancreas and gall bladder.

Blood of these veins is collected into the portal vein.

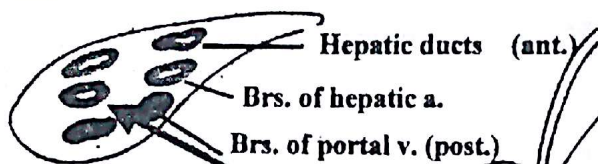
Portal vein



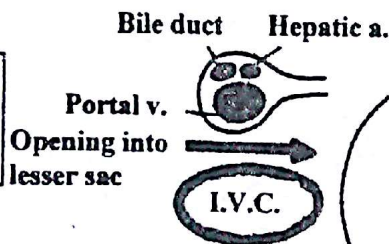
Origin: This large vein is formed behind the neck of pancreas by the union of the superior mesenteric and splenic veins.

Course and relation:

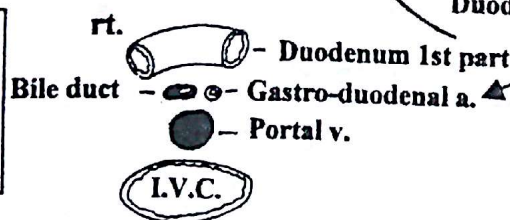
Relations in porta hepatis



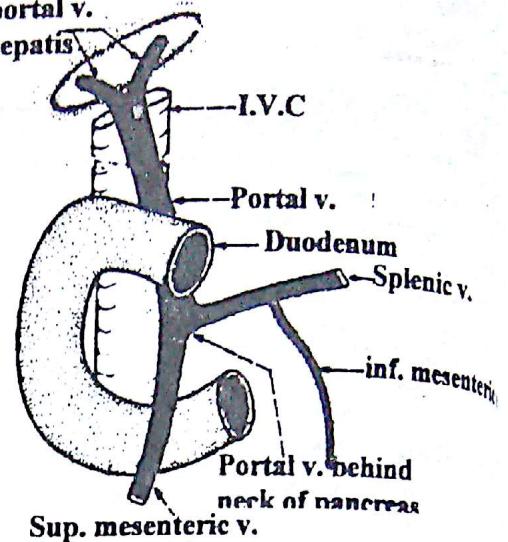
Relations in lesser omentum



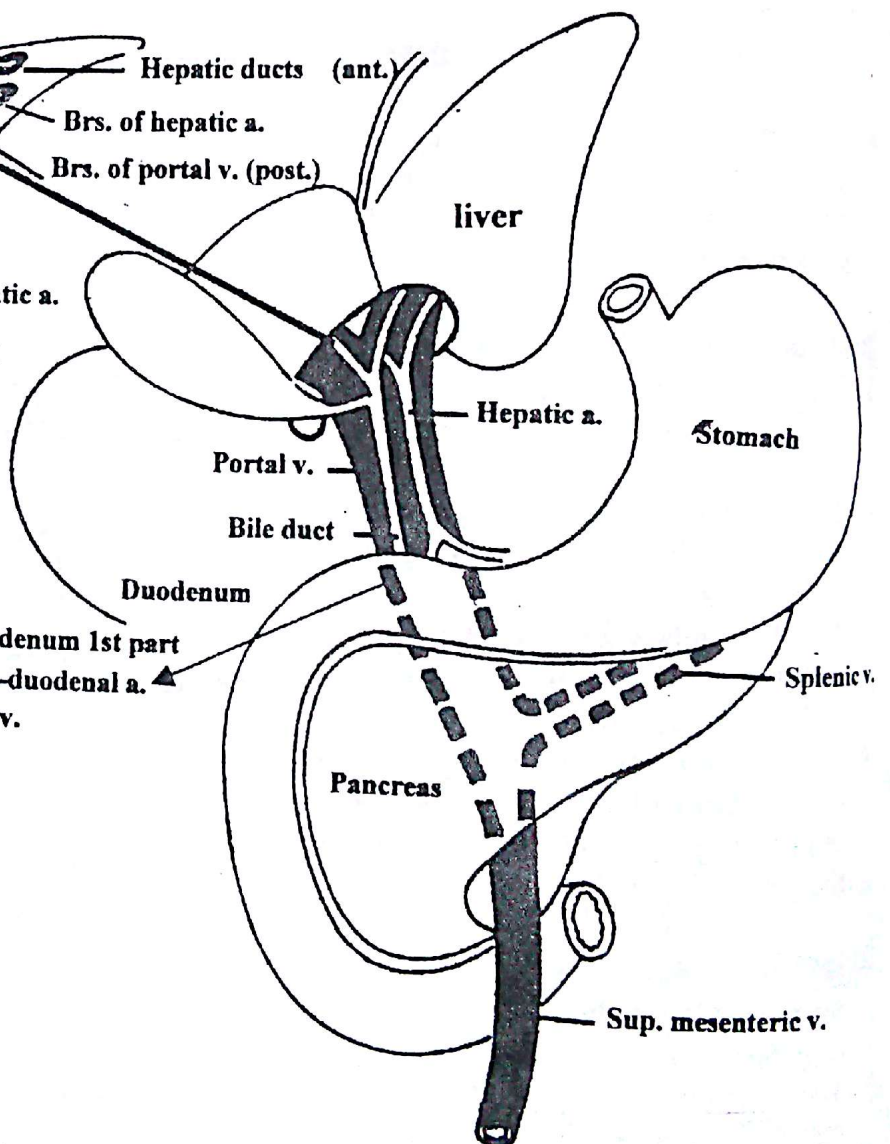
Relations behind 1st part of duodenum



Branches of portal v. in the porta hepatis



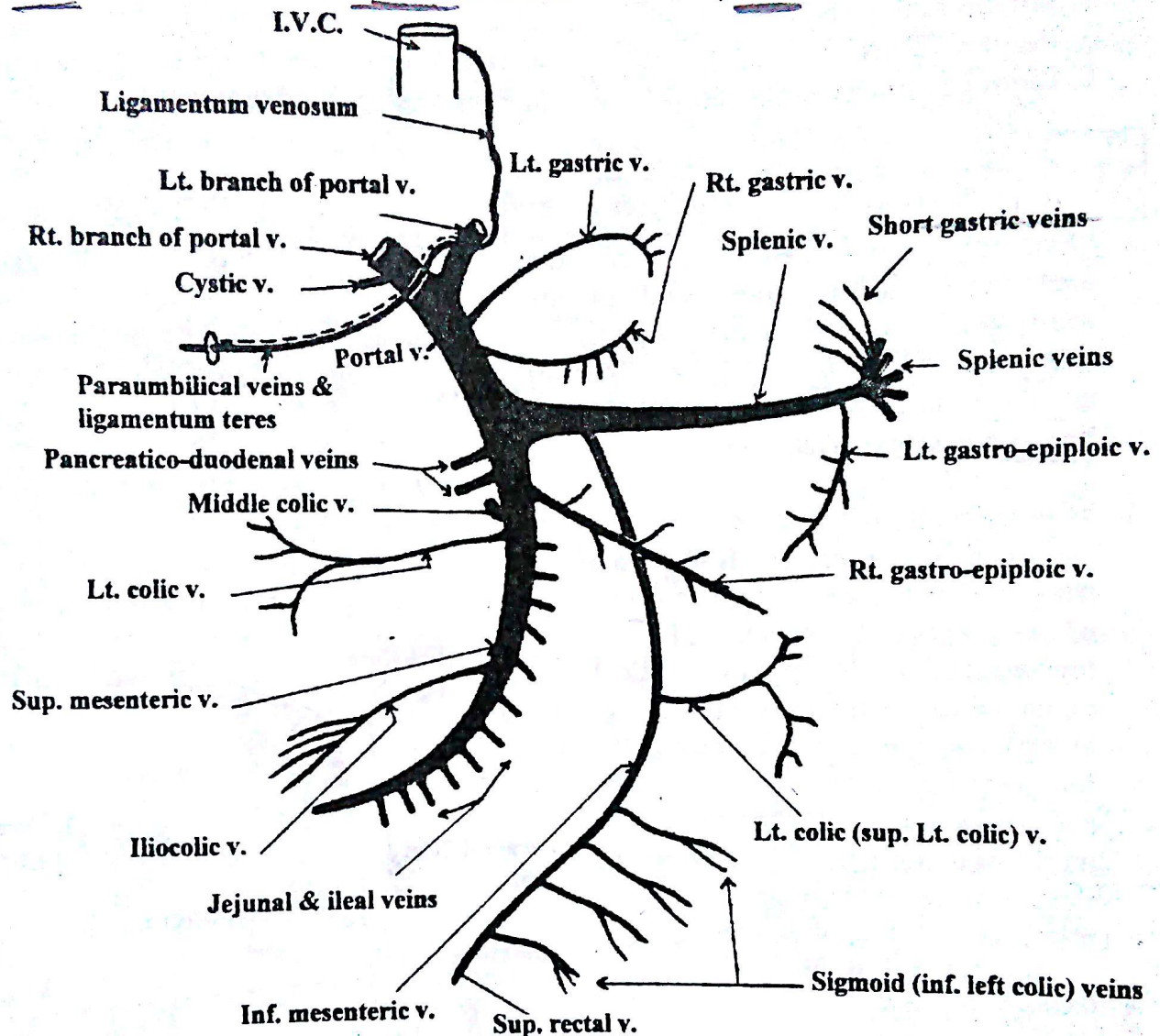
- The vein ascends in front of the inferior vena cava and behind the first part of the duodenum.
- During this part of its course, the bile duct and gastro-duodenal artery lie in front of it.
- Then, it ascends in the free margin of the lesser omentum, in front of the opening into the lesser sac.
- During this part of its course, the bile duct and hepatic artery lie in front of it.
- The bile duct lies toward the right, & the hepatic artery lies towards left side.



- As it reaches to the **porta hepatis**, the **portal vein** divides into **right and left branches**.
- Each passes into the corresponding lobe of the liver.
- **in the porta hepatis** the 2 **hepatic ducts** lie **anterior**, the 2 branches of the hepatic artery in the middle and the 2 branches of the portal vein lie **posterior**.
- The right branch of the portal vein receives the **cystic vein** from the gall bladder.

Tributaries:

1. **Splenic vein.**
2. **Superior mesenteric vein.**
3. **Left gastric vein.**
4. **Right gastric vein.**
5. **Paraumbilical veins.**
6. **Cystic veins.**



Splenic vein:

- Begins by the union of **five or six** splenic veins at the **hilum of the spleen**.
- It runs across the posterior abdominal wall **behind the body of pancreas**.
- **Behind the neck of pancreas it unites with the superior mesenteric vein at a right angle to form the portal vein.**
- The **splenic vein** receives the following tributaries:
 - a) **Short gastric veins.**
 - b) **Left gastro-epiploic vein.**
 - c) **Pancreatic veins.**
 - d) **Inferior mesenteric vein.**

Inferior mesenteric vein:

- Is the **continuation of the superior rectal vein** at the **middle of the left common iliac artery**,
- It lies on the left side of the **inferior mesenteric artery**.
- **The ureter lies on its lateral side.**
- It **ends in the splenic vein** about one inch from the portal vein.

- It receives the inferior (sigmoid) and superior left colic veins.

Superior mesenteric vein:

- This vein runs along the right side of the artery in the root of the mesentery.
- It ends behind the neck of pancreas by the union with the splenic vein to form the portal vein.

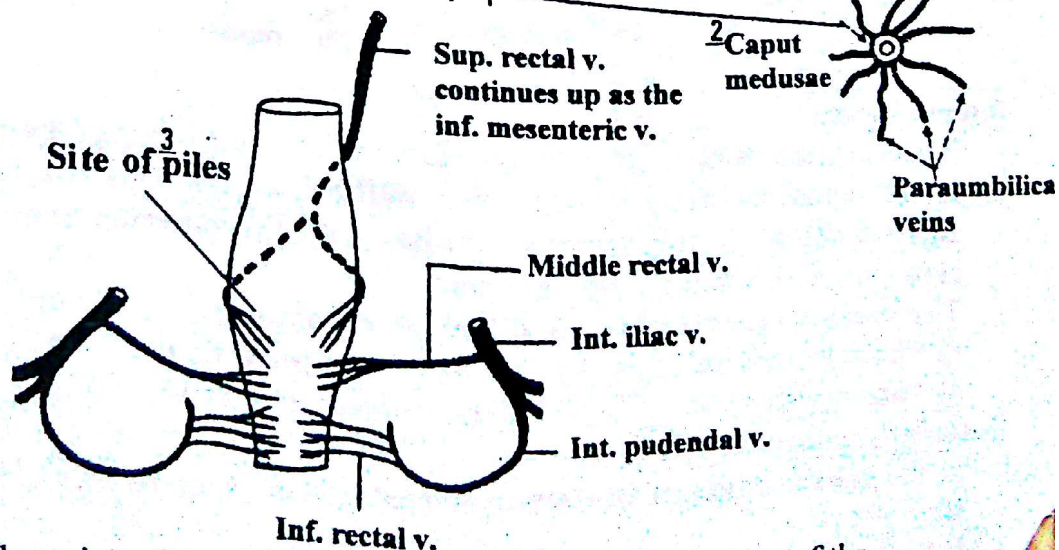
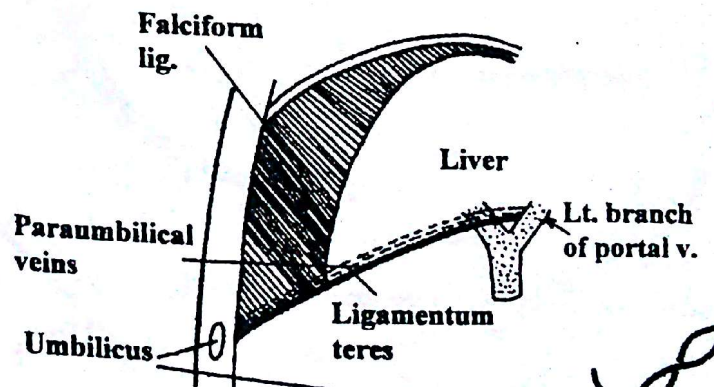
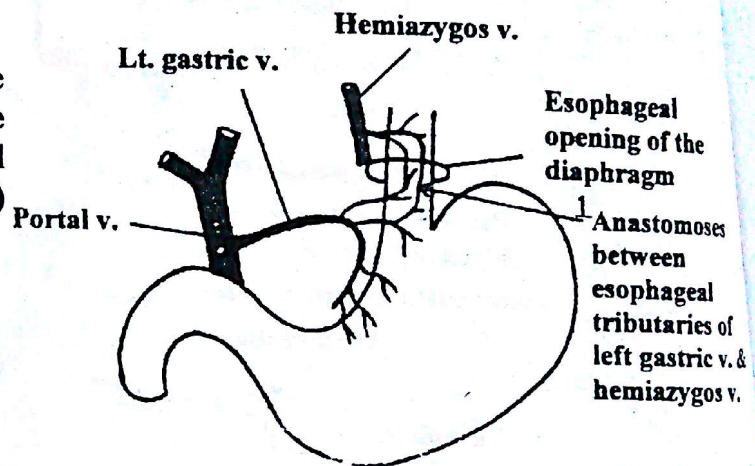
It receives the following tributaries:

1. Jejunal and ileal veins.
2. Ileocolic vein.
3. Right colic vein.
4. Middle colic vein.
5. Right gastro-epiploic vein.
6. Pancreatico-duodenal veins.



Porto-systemic anastomoses

1. **"Esophageal varices"** it is the anastomosis at the lower end of the esophagus between the esophageal tributaries of the left gastric vein (portal) and the esophageal tributaries of the hemiazygos vein (systemic).
2. **"Caput medusae"**: it is the anastomosis between the left branch of the portal vein (portal) and the veins of the anterior abdominal wall (systemic) through the paraumbilical veins (which are minute veins passing along the ligamentum teres through the falciform ligament).
- In the caput medusae, the veins of the anterior abdominal wall appear tortuous, dilated and radiating around the umbilicus.
3. **"Piles"**: it is the anastomosis in the submucosa of the lower part of the rectum and upper part of the anal canal between the tributaries of the superior (portal), & middle and inferior rectal veins (systemic)



4. Anastomosis between the veins of the liver, stomach and colon and the veins of the posterior abdominal wall through the bare areas of these organs.

SPLEEN

Position: In the left hypochondrium, between the fundus of the stomach and diaphragm.

Its long axis is in the line of the tenth rib.

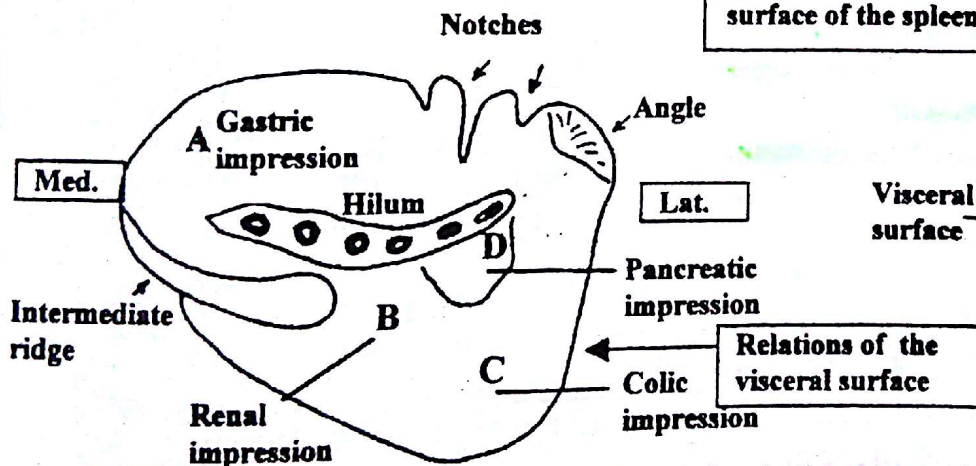
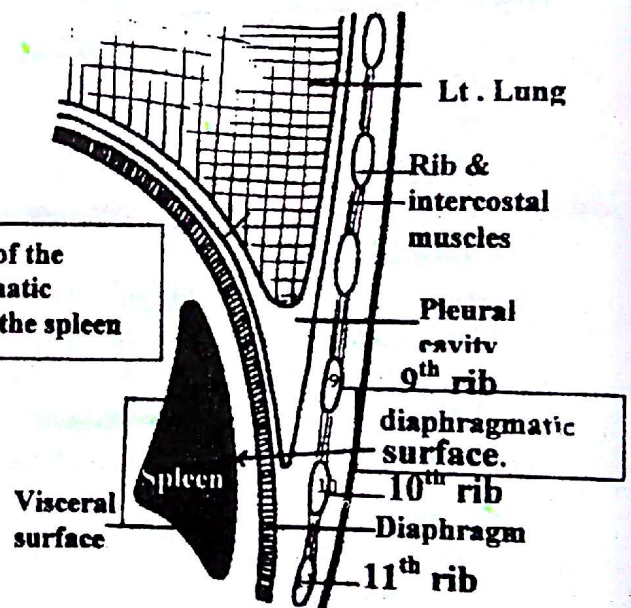
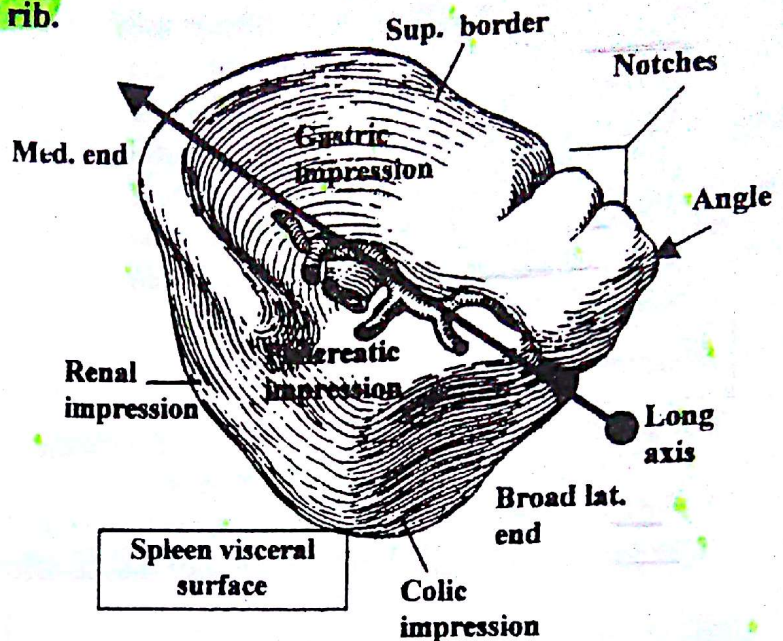
Shape:

- It has a tapering medial end.
- It has a broad lateral end.
- The spleen has a superior border which is notched near the lateral end and forms a projection called the angle of the spleen at its junction with the lateral end.
- It has an inferior border which is smooth and more rounded than the superior border.
- It has two surfaces: diaphragmatic surface and visceral surface.

Relations:

1. **Diaphragmatic surface:** smooth and convex.

It is related to the diaphragm which separates it from the lowermost parts of the left pleura and lung, the ninth, tenth and eleventh ribs and intercostal muscles.



2. **Visceral surface:** directed towards the abdominal cavity and carries impressions for the stomach (A), left kidney (B), left colic flexure (C) and tail of pancreas (D).

(A). **Gastric impression:** large and concave.

- It is related to the posterior wall of the stomach.
- The lower part of this impression presents the hilum of the spleen.
- The gastric impression lies below the superior border, and is separated from the renal impression by an intermediate margin (ridge).

(B). **Renal impression:** a gently concave impression, close to the inferior border. It is related to the front of the left kidney.

(C). **Colic impression:** a flattened impression close to the lateral end, which is related to the left colic (splenic) flexure.

(D). **Pancreatic impression:** a small area between the colic impression and the lateral part of the hilum. This area is directly related to the tail of pancreas.

Peritoneal connections:

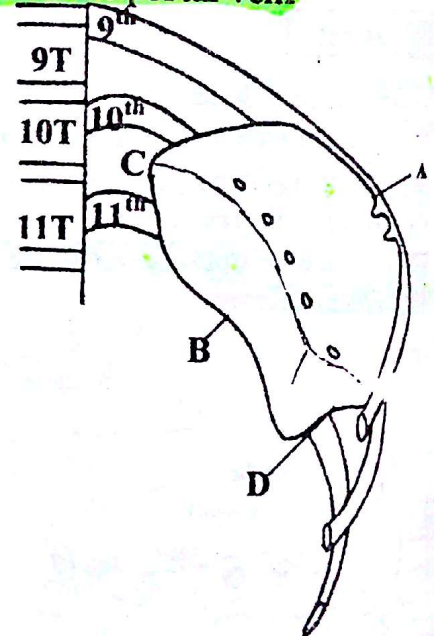
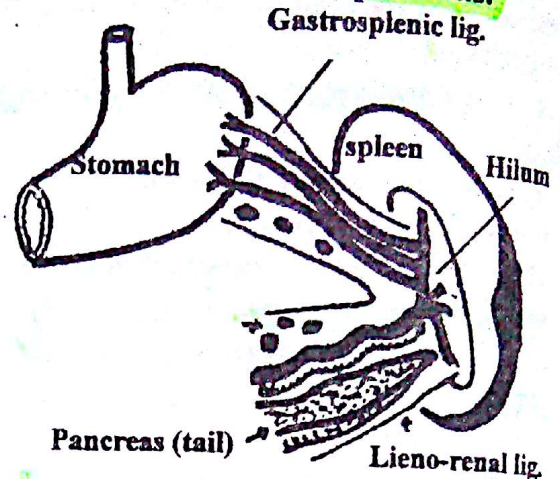
The spleen is completely surrounded by peritoneum of the greater sac, and is connected to the left kidney by the **lienorenal ligament** (which contain the tail of pancreas & splenic vessels), and to the stomach by the **gastro-splenic ligament**. (Which contains the short gastric vessels)

Vessels of the spleen

1. **Splenic artery:** arises from the coeliac trunk and ends in about 5 terminal branches which enter the hilum of the spleen.
2. **Splenic vein:** runs to the right below the splenic artery to end behind the neck of the pancreas by joining the superior mesenteric vein to form the portal vein.

Surface anatomy of the spleen

- Lies in the left hypochondrium.
- Its long axis corresponds to the posterior part of the tenth rib.
- Its **upper border (A)** corresponds to the upper border of the ninth rib;
- while its **lower border (B)** corresponds to the lower border of the eleventh rib.
- Its **medial end (C)** is one and half inches lateral to the tenth thoracic spine.
- Its **lateral end (D)** reaches to the mid-axillary line.



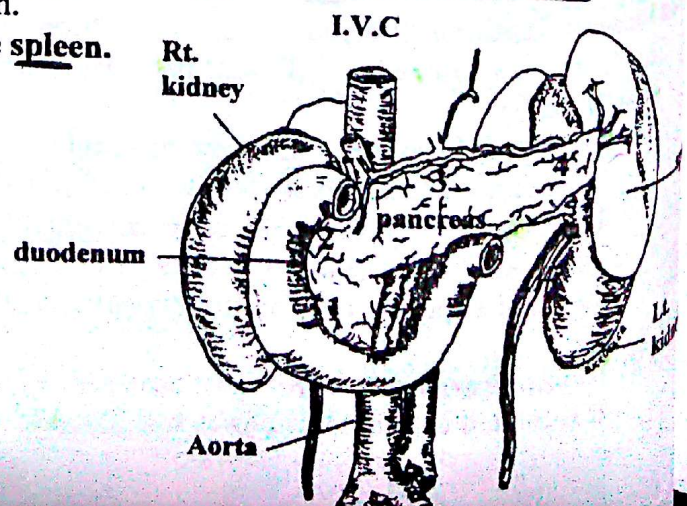
PANCREAS

This is an elongated gland which lies transversely across the posterior abdominal wall behind the lesser sac of peritoneum.

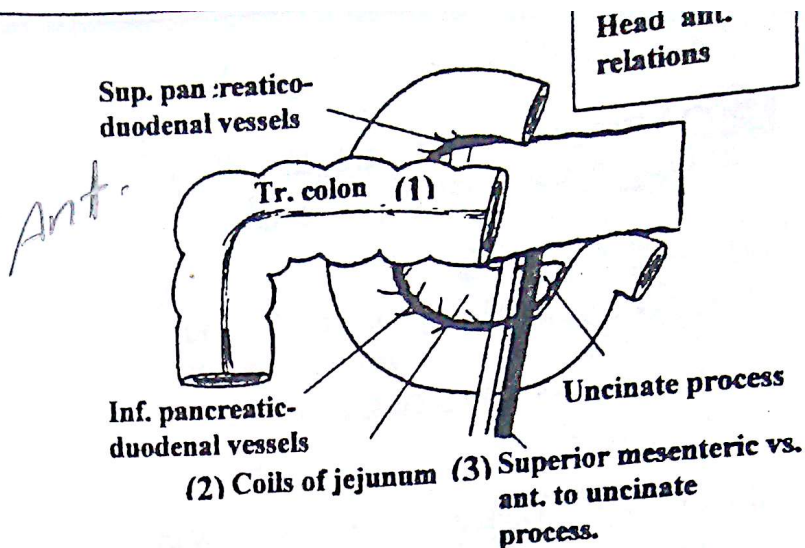
- It extends from the duodenum to the spleen.
- It is composed of a **head (1)**, **neck (2)**, **body (3)** and **tail (4)**.

Head lies in the concavity of the duodenum the lower and left part of the head forms a projection behind the superior mesenteric vessels.

This projection is known as the **uncinate process of pancreas**.



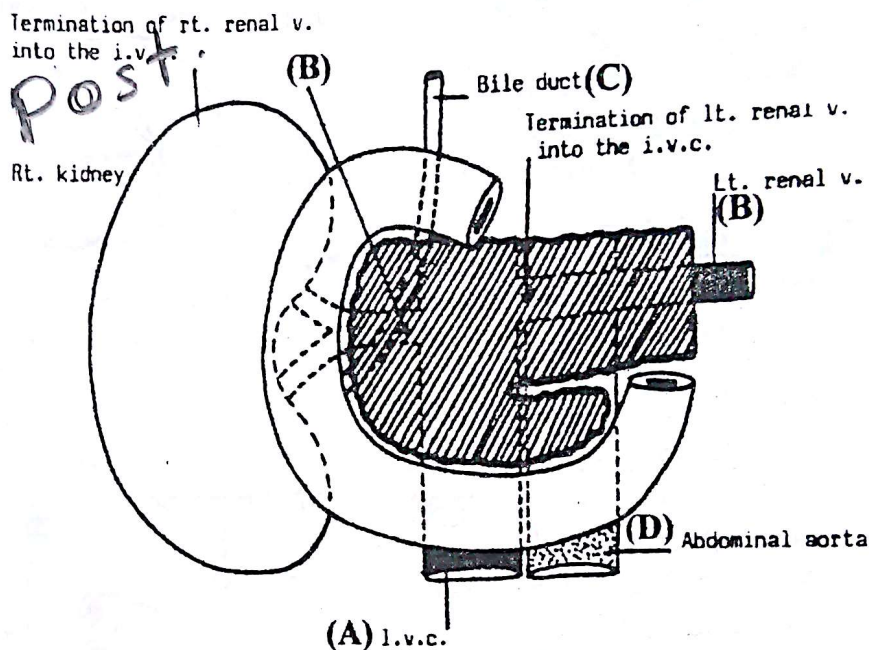
- The superior and inferior pancreaticoduodenal arteries run in the groove between it and the duodenum.
- Its anterior surface of the head is directly related to the transverse colon (1), but its lower part is covered with peritoneum and is related to coils of the jejunum (2).
- The anterior surface of the uncinete process is related to superior mesenteric vessels (3).



- Its posterior surface of the head is directly related to the inferior vena cava (A) and the termination of the renal veins (B).

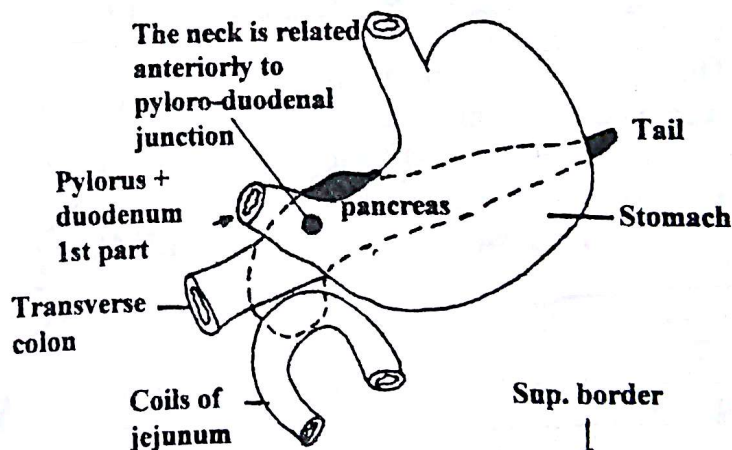
The upper lateral part of this surface is related to the bile duct (C) which forms a deep groove or may be embedded in the substance of the head.

- The posterior surface of the uncinete process is related to abdominal aorta (D).

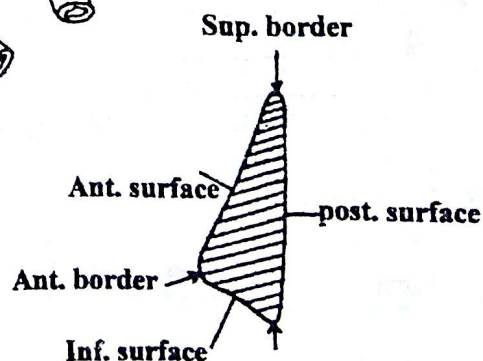
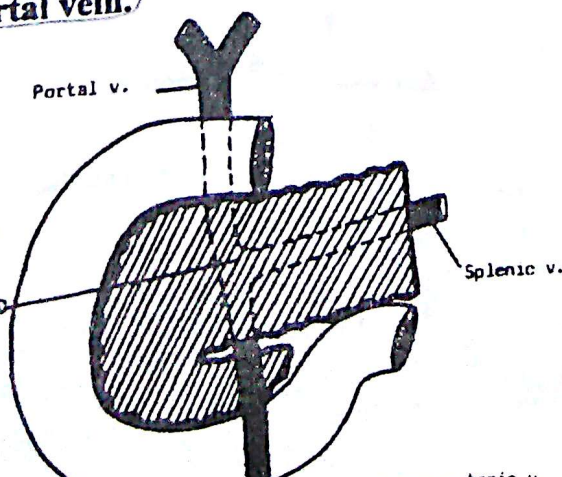


Neck: a narrow portion which joins the body with the head.

- **Anteriorly** it is covered with peritoneum of the lesser sac where it is related to the pylorus and first part of the duodenum.
- **Posteriorly** it is related to the end of the superior mesenteric and splenic veins where they join together to form the portal vein.



The neck of pancreas is related posteriorly to the union of splenic & sup. mesenteric veins to form the portal vein.



Section in the body of pancreas showing 3 borders & 3 surfaces

Body: triangular in cross section, i.e. it has three surfaces and three borders.

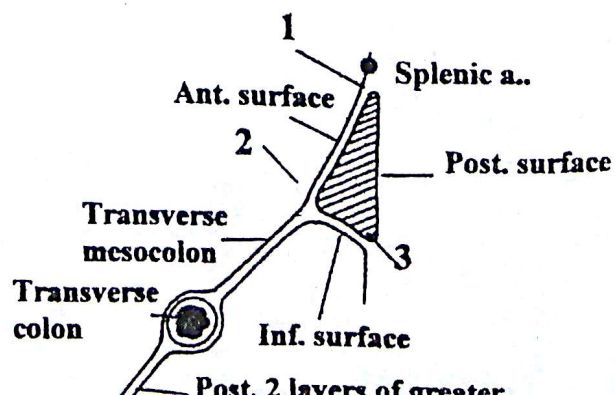
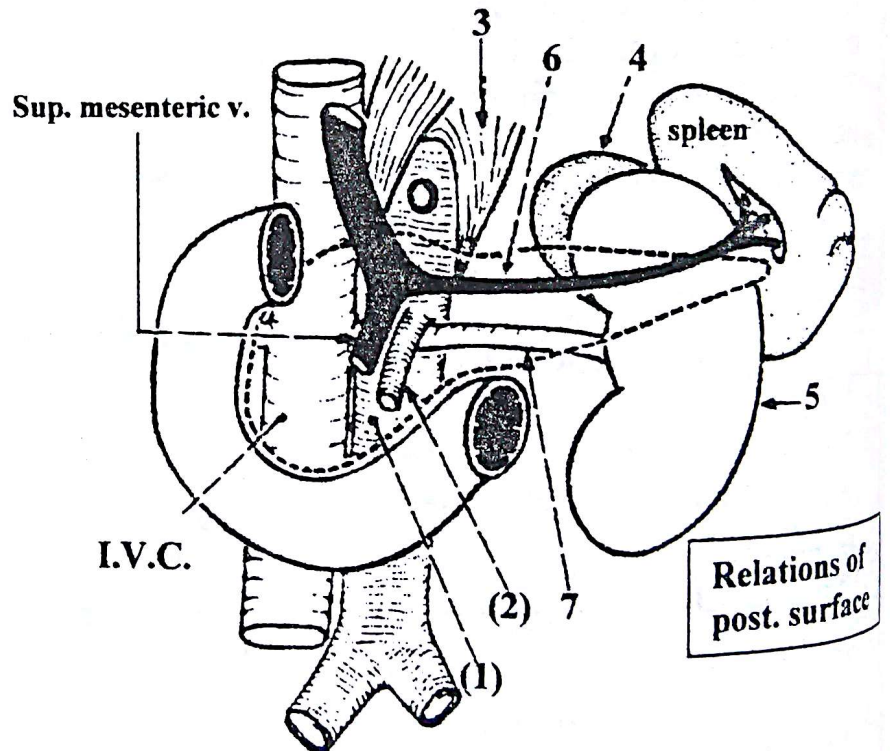
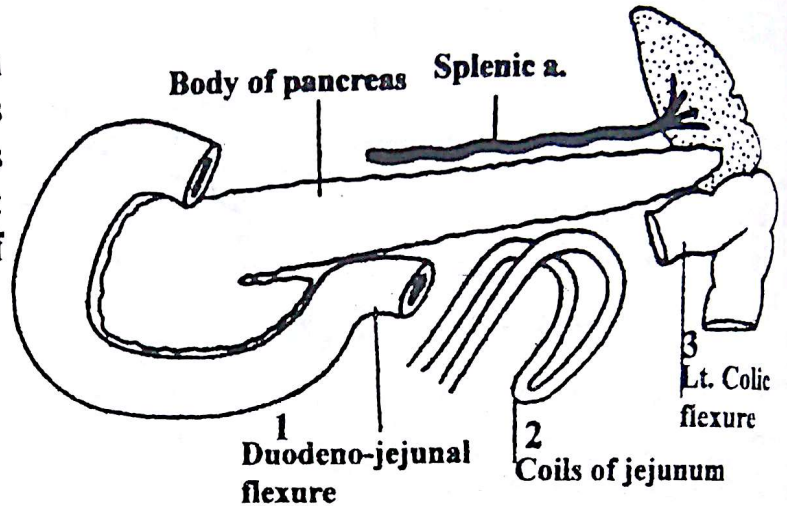
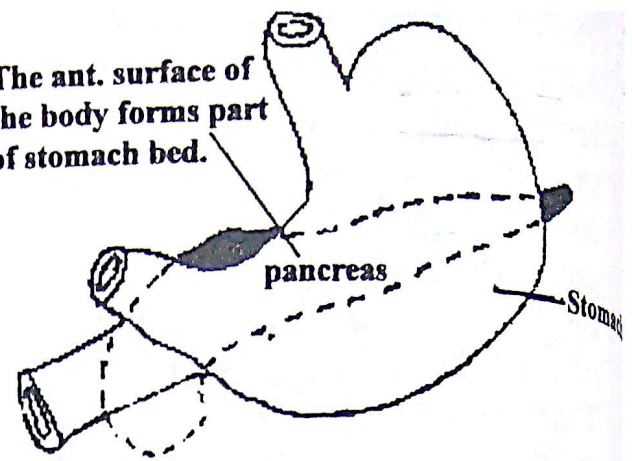
The surfaces are:

1. **Anterior surface** covered with peritoneum of the posterior wall of the lesser sac and forms a part of the stomach bed.
2. **Inferior surface:** covered with peritoneum of the greater sac, and is related to the following structures arranged from the right to the left side: duodeno-jejunal flexure (1), coils of jejunum (2) and left colic flexure (3).
3. **Posterior surface:** not covered by peritoneum and lies directly on the following structures from the right to the left side:
 - Abdominal aorta (1) and origin of the superior mesenteric artery (2),
 - left crus of diaphragm (3),
 - left psoas major,
 - left suprarenal gland (4) and left kidney (5).
 - The posterior surface is separated from these structures by the splenic vein (6) above and the left renal vein below (7).

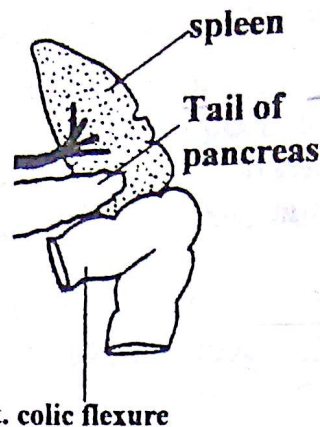
The borders are:

1. **Upper border** related to the splenic artery.
2. **Anterior border** gives attachment to the transverse mesocolon.
3. **Inferior border** separates the inferior from the posterior surface.

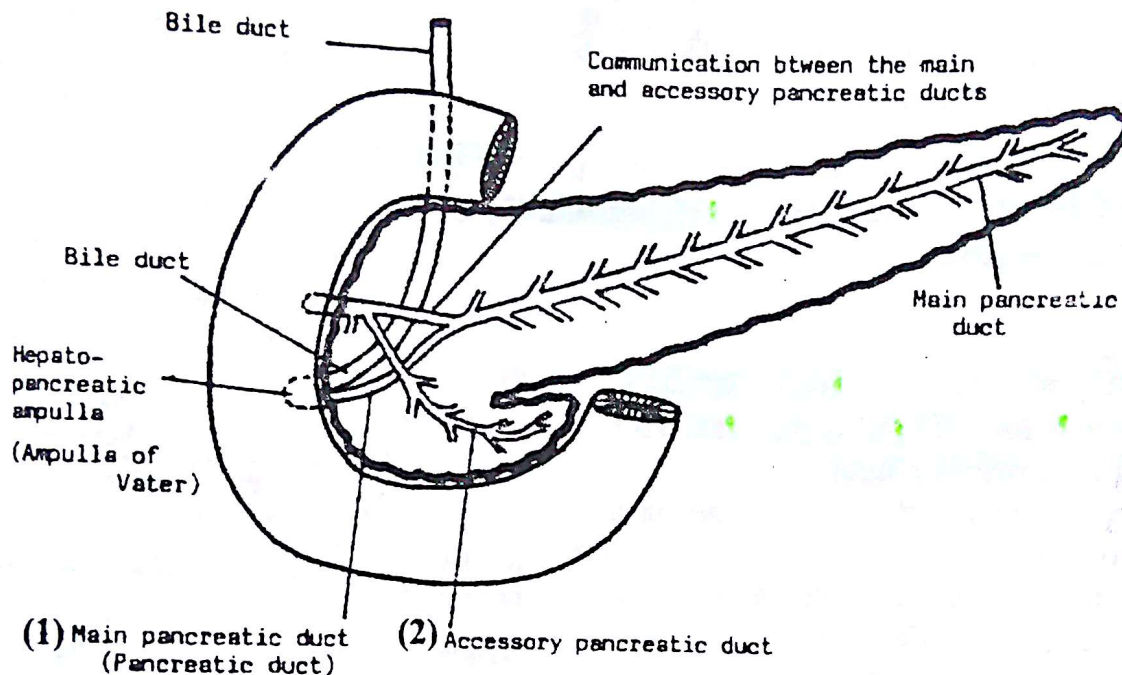
The ant. surface of the body forms part of stomach bed.



Tail of pancreas is the narrow left extremity of the gland. It passes between the two layers of the **lienorenal ligament** and comes into direct relation with the **spleen**.



Pancreatic duct (1) (main pancreatic duct):



runs transversely through the substance of the gland from the left to the right.

- In the head, it curves downwards, back-wards and to the right, coming into the left side the bile duct.
- The two ducts unite in the wall of the second part of the duodenum forming a dilatation known as the **hepato pancreatic ampulla (ampulla of Vater)**.
- This ampulla opens on the summit of an elevation called the **major duodenal papillae**.

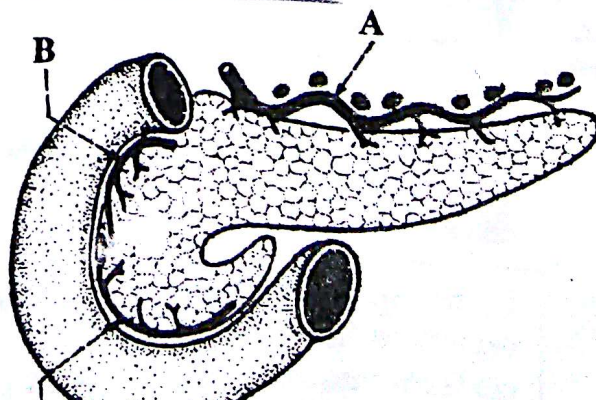
* **Accessory pancreatic duct (2):** a small duct which begins in the lower part of the head and ascends in front of the main duct.

Then, it curves to the right and opens into the second part of the duodenum on the summit of an elevation called the **minor duodenal papilla** (about one inch above major duodenal papilla).

It is connected to the main duct within the substance of the head by a communicating duct.

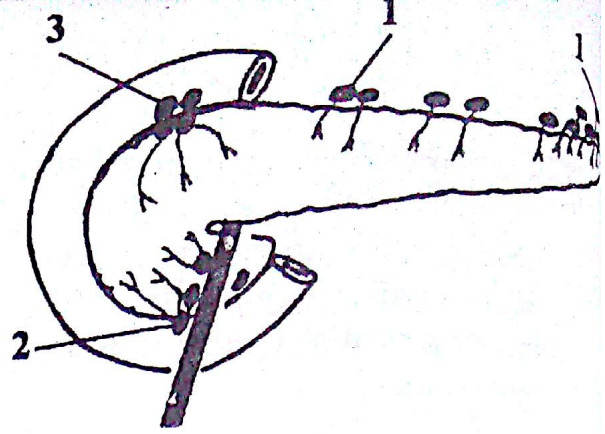
Arterial supply:

1. Pancreatic branches of the **splenic artery (a)**.
2. **Superior pancreaticoduodenal artery (b)**.
3. **Inferior pancreaticoduodenal artery (c)**.



Lymphatic drainage of pancreas:

- The greater part of the pancreas drains into pancreatico-splenic lymph nodes (1). These lymph nodes lie along the splenic vessels and extend into the lienorenal and gastrosplenic ligaments.
- Few vessels from the head of the pancreas drain into the superior mesenteric (2) and pyloric (3) (subpyloric) lymph nodes.



LIVER

Position:

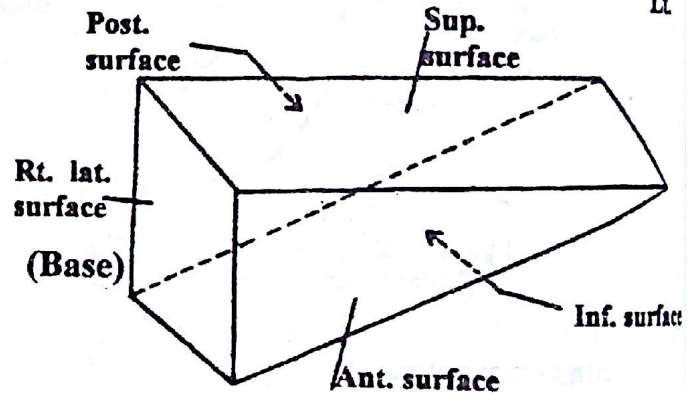
The liver occupies the whole of the **right hypochondrium (1)** and parts of the **epigastrium (2)** and **left hypochondrium (3)**.

Shape:

Wedge-shaped, having five surfaces: **anterior, superior, posterior, inferior and right lateral surfaces.**

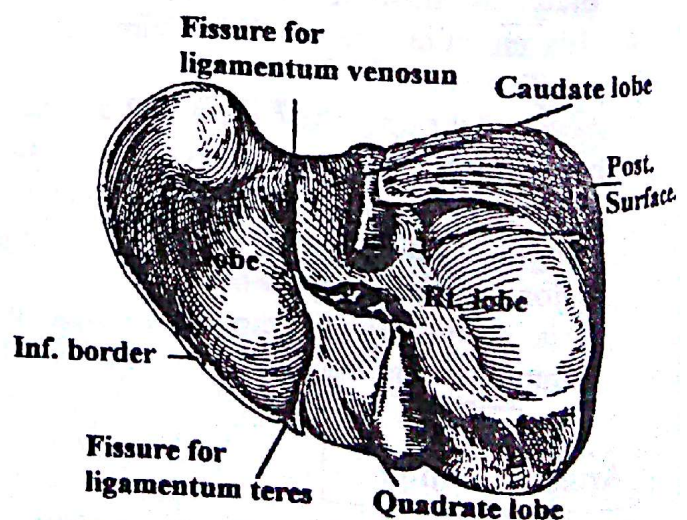
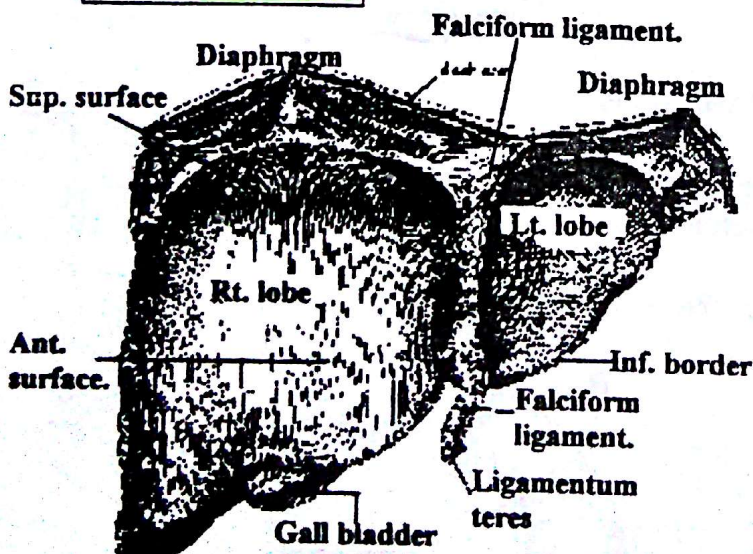
- The right lateral surface forms the base of the wedge.
- The borders which separate the surfaces are rounded and ill-defined.
- **Only, a sharp inferior border separates the anterior and right lateral surfaces from the inferior surface.**
- The surfaces are covered with peritoneum except for a bare area on the posterior surface.

Rt.



Lt.

Lobes of the liver:



Liver – the falciform ligament separates its superior and anterior surfaces into right and left lobes.

Liver – the fissure for ligamentum venosum in the posterior surface and the fissure for ligamentum teres in the inferior surface separate the liver

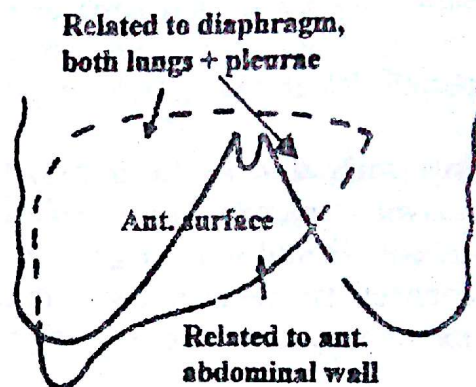
- The liver is composed of two lobes: a large right lobe and a smaller left lobe. The two lobes are separated by:

1. The attachment of the falciform ligament: on the anterior and superior surfaces.
 2. The fissure for ligamentum venosum: on the posterior surface.
 3. The fissure for ligamentum teres: on the inferior surface.
- A circumscribed part of the right lobe on the inferior surface forms the quadrate lobe.
 - Another circumscribed part of the right lobe on the posterior surface forms the caudate lobe.

Surfaces of the liver

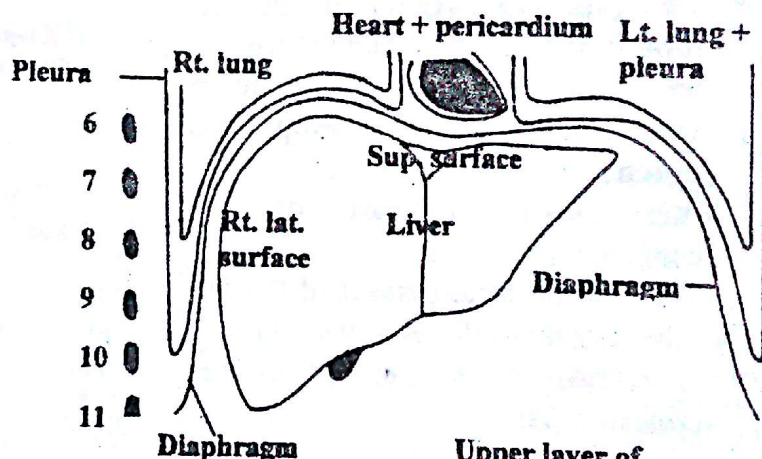
* Anterior surface:

- Related to the diaphragm and anterior abdominal wall.
- The diaphragm separates it from the pleura and base of the lung on each side.



* Superior surface:

- Related to the diaphragm which separates it from the pleura and base of the lung on each side and the pericardium and the heart in the middle.



* Right lateral surface:

- Related to the diaphragm which separates it from the right pleura, right lung and ribs from 6 to 11 on the right side.

* Posterior surface:

Composed of three main parts:

(A) bare area, (B) groove for I.V.C. & (C) caudate lobe.

(A). Bare area: triangular in shape.

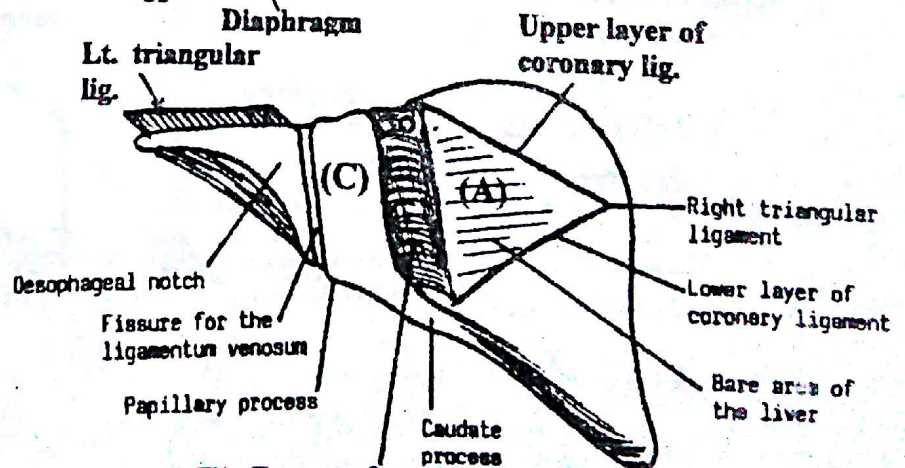
- Its apex is directed towards the right side.
- Its base is formed by the groove for the inferior vena cava.

Superiorly, it is bounded by the upper layer of coronary ligament.

Inferiorly, it is bounded by the lower layer of coronary ligament.

- The upper and lower layers of coronary ligament meet at the apex of the bare area to form the right triangular ligament.
- The bare area is devoid of peritoneal covering & is in direct contact with the diaphragm.

(B). Groove for the inferior vena cava: a deep groove at the base of the bare area.

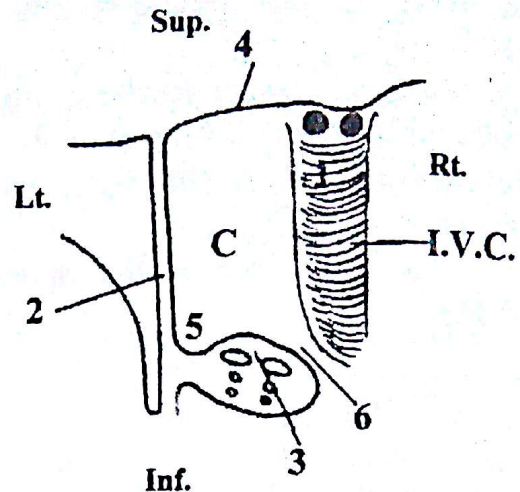


- It is devoid of peritoneal covering.
- It lodges the upper part of the inferior vena cava.
- The upper part of the groove is pierced by the right and left hepatic veins.

(C). **Caudate lobe:** to the left of the groove for the inferior vena cava.

This lobe is bounded

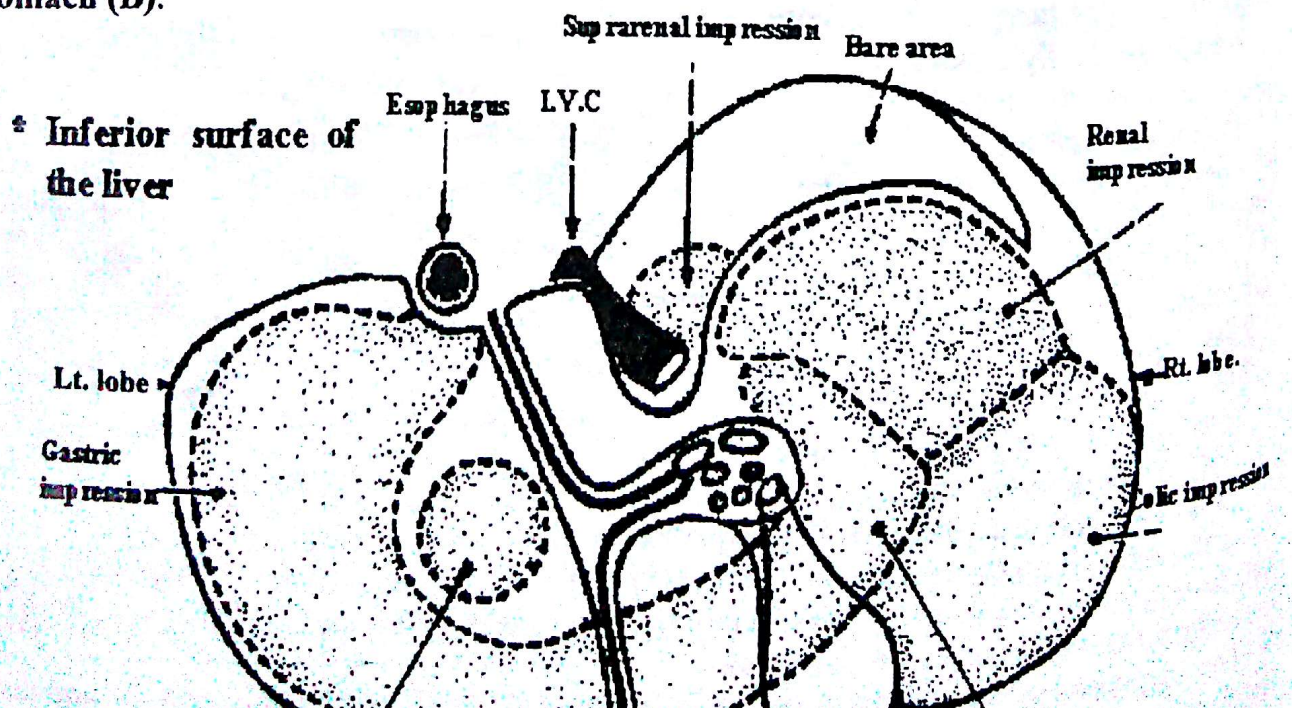
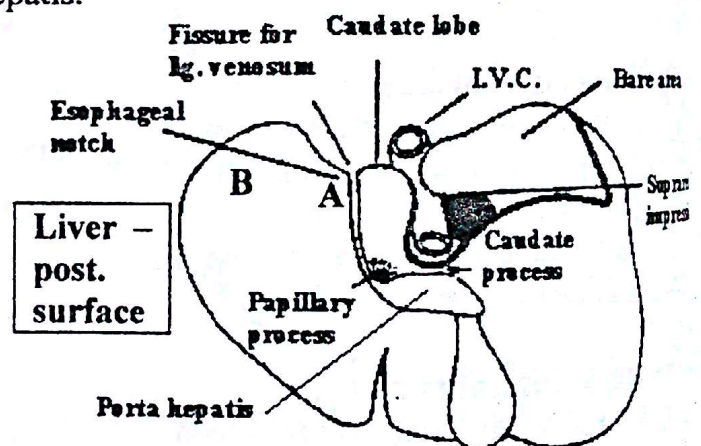
- On the right side by the groove for the inferior vena cava (1),
- On the left side by the fissure for ligamentum venosum (2),
- Inferiorly by the porta hepatis (3), and
- Superiorly by the left hepatic vein (4) and the ligamentum venosum as it curves to join the inferior vena cava.



- Inferiorly and to the left, the caudate lobe forms a protection of variable size known as the **papillary process (5)**.
- Inferiorly and to the right, a process of liver substance called **caudate process (6)** connects the caudate lobe with the rest of the right lobe and separates the groove for the inferior vena cava from the porta hepatis.

* The posterior aspect of the left lobe is marked by a notch close to the fissure for ligamentum venosum, called the **esophagus notch (A)** which is related to the abdominal part of the esophagus.

- The thin posterior aspect of the left lobe, lateral to the esophageal notch is related to the fundus of the stomach (B).

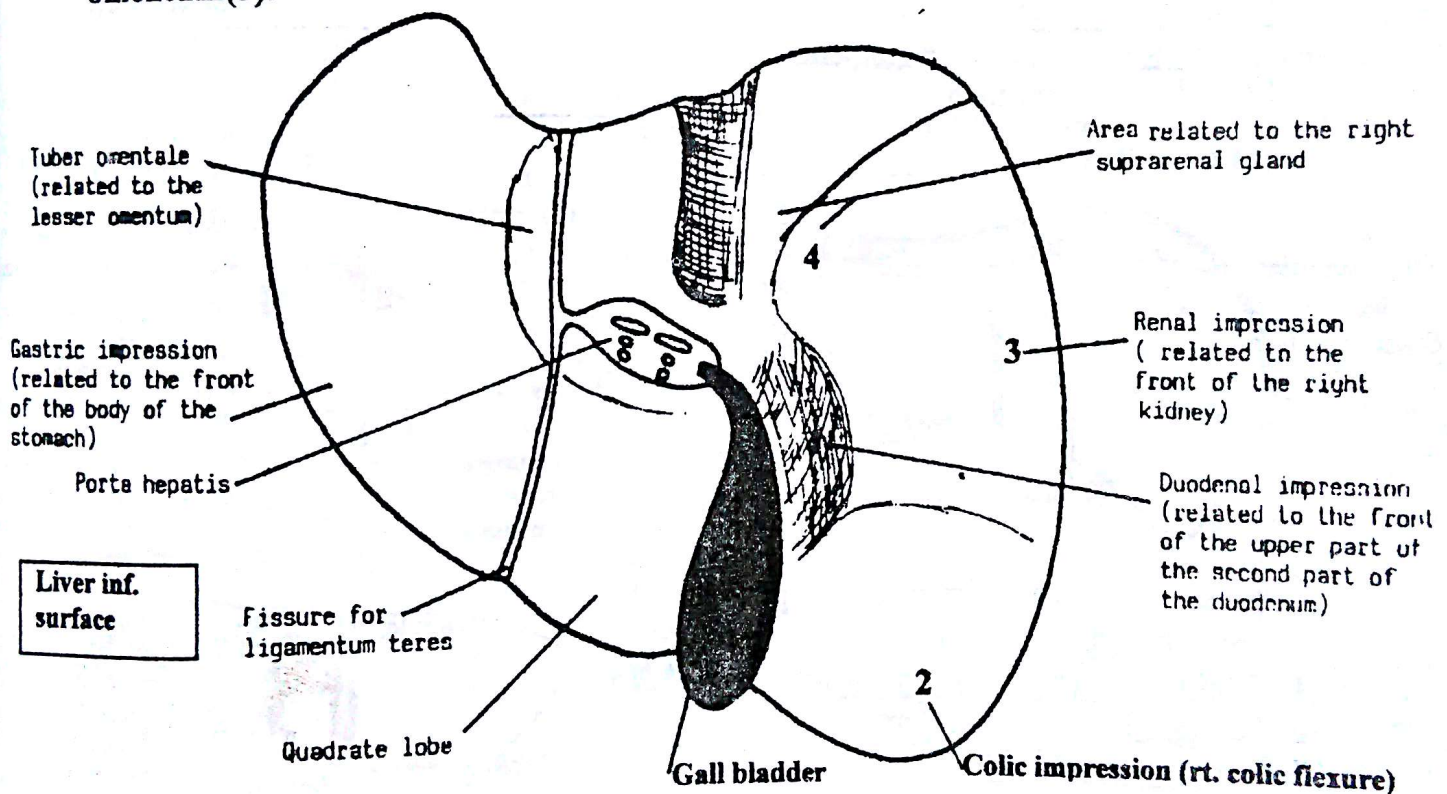
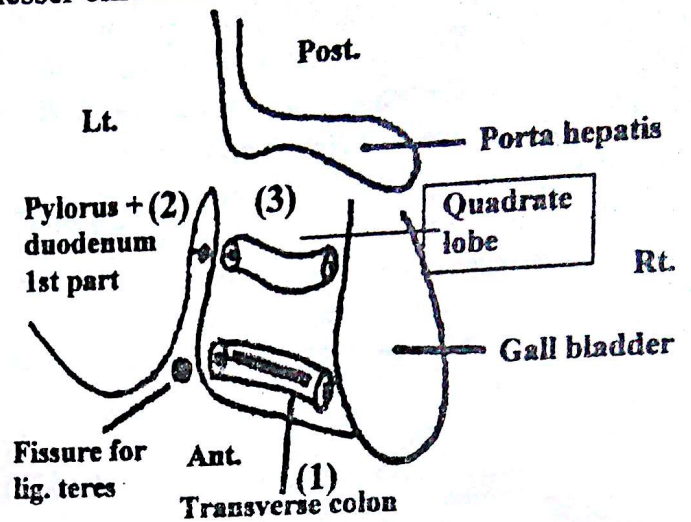


* Inferior surface

- The inferior surface of the left lobe is marked by the **gastric impression** which is related to the body of the stomach.
- At the right side of the gastric impression there is a smooth and rounded elevation called the **tuber omentale** which is related to the lesser omentum.

Quadrato lobe: This is a rectangular part of the right lobe on the inferior surface of the liver.

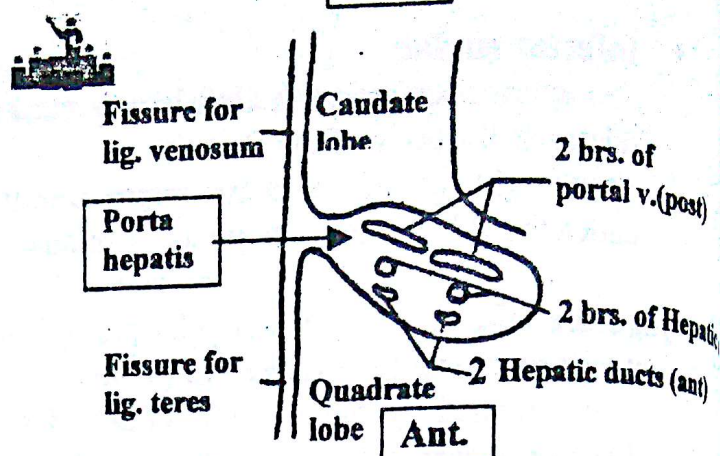
- It is bounded by the inferior border of the liver **anteriorly**, porta hepatis **posteriorly**, fissure for ligamentum teres on the left side and gall bladder fossa on the right side.
- The **anterior part** of the quadrato lobe is related to the **transverse colon (1)**.
- Its **middle part** is related to the **pylorus and first part of the duodenum (2)**.
- Its **posterior part** is related to the **lesser omentum (3)**.



- The **inferior surface of the right lobe**, on the right side of the gall bladder fossa, is related to the **second part of the duodenum, right colic flexure and right kidney**.
- The **duodenal impression (1)** is lateral to the neck of the gall bladder, and is related to the upper portion of the second part of the duodenum.
- The **colic impression (2)** is anterior in position close to the inferior border. It is related to the right colic flexure (hepatic flexure).
- The **renal impression (3)** is a well marked smooth impression which lies behind the colic impression and lateral to the duodenal impression. It is related to the front of the right kidney.
- This surface is also related to the **right suprarenal gland (4)** close to the groove for the inferior vena cava.

Porta hepatis: (hilum of the liver).

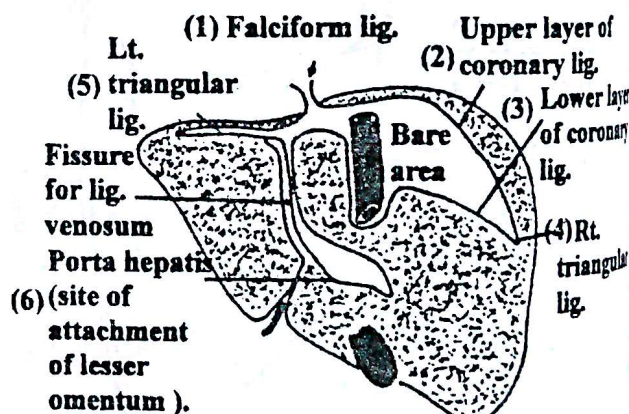
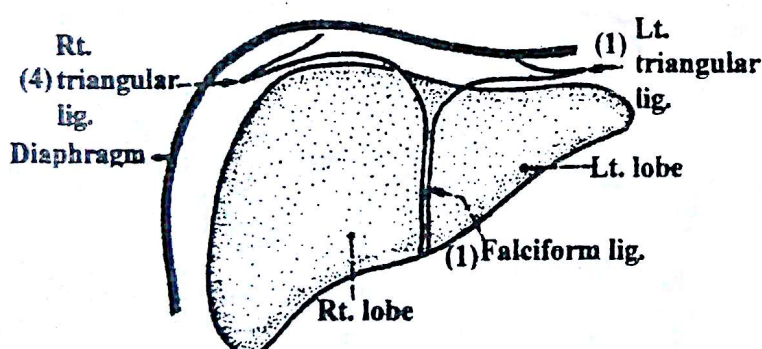
- It is bounded **anteriorly** by the **quadrate lobe**; and
- **Posteriorly** by the **caudate lobe** and **caudate process**.
- The **structures passing through the porta hepatis** are arranged as follows:
 1. **Hepatic ducts, anteriorly.**
 2. **Hepatic artery** and its right and left branches, **intermediate** in position.
 3. **Portal vein** and its right and left branches, **posteriorly.**
- The hepatic artery is accompanied by the **hepatic plexus of nerves**.
- Also, **some lymph vessels** come out through the porta hepatis.



Peritoneal connections:

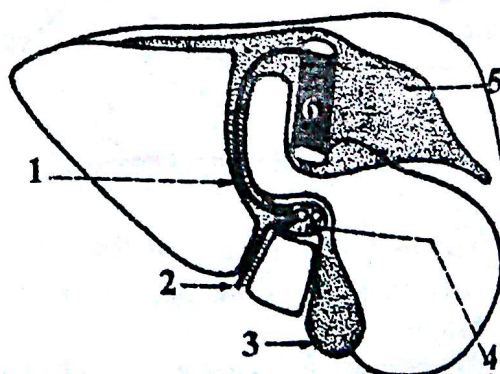
The liver has many peritoneal connections:

1. Falciform ligament.
2. Upper layer of coronary ligament.
3. Lower layer of coronary ligament.
4. Right triangular ligament.
5. Left triangular ligament.
6. Lesser omentum.



* Areas of liver devoid of peritoneal covering (bare areas)

1. Fissure for ligamentum venosum.
2. Fissure for ligamentum teres.
3. Fossa for gall bladder.
4. Porta hepatis.
5. Bare area of the liver (the largest).
6. the groove for the inferior vena cava.



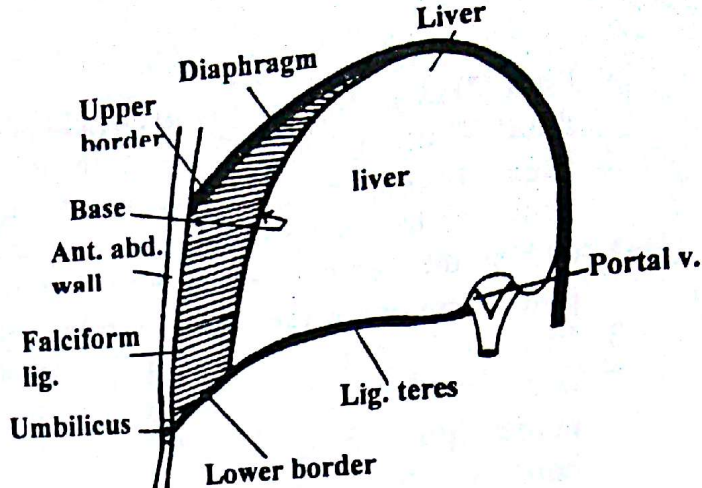
• Remember that about falciform ligament:

It is a **sickle-shaped** fold of peritoneum which **connects the liver to the diaphragm and upper part of the anterior abdominal wall.**

The falciform ligament has an **apex**, a **base** and **2 borders**:

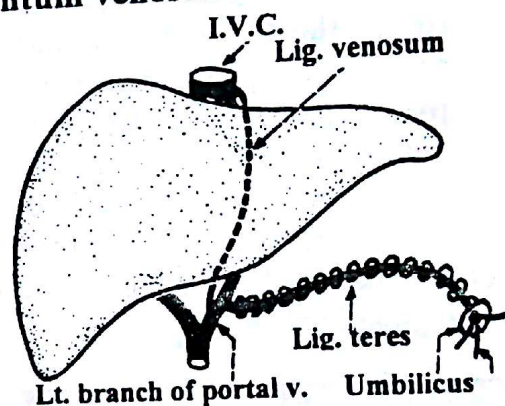
- * **Apex:** lies at the back of the umbilicus.
- * **Base:** is attached to the line between the right and left lobes of the liver. This line extends over the anterior and superior surfaces of the liver.

- * **Lower border:** is free and concave, and here the 2 layers are continuous together and **enclose the ligamentum teres.**
- * **Upper border:** is convex and attached to the supra-umbilical part of the anterior abdominal wall as well as to the under surface of the diaphragm.



Remember that about ligamentum teres and ligamentum venosum:

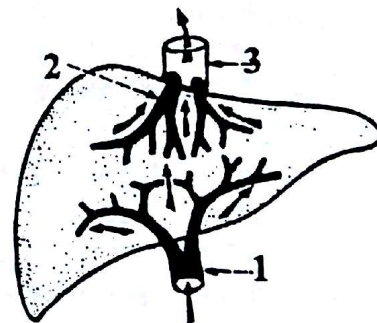
- **Ligamentum teres:** is the obliterated and fibrosed umbilical vein.
 - It passes from the umbilicus in the free margin of the falciform ligament.
 - Then, it passes in the bottom of a fissure on the inferior surface of the liver (**fissure for ligamentum teres**).
 - It ends in the left branch of the portal vein.



- **Ligamentum venosum:** is the obliterated and fibrosed ductus venosus.
 - It passes in the bottom of a fissure on the posterior surface of the liver (**fissure for ligamentum venosum**).
 - It connects the left branch of the portal vein with the inferior vena cava.

Remember that about the flow of venous blood through the liver.

- The venous blood enter the liver through the **portal vein (1)**.
- The blood is collected from the liver in the **right and left hepatic veins (2)** (one from each lobe). These are very short veins which immediately end in the upper part of the **inferior vena cava (3)**.



Vessels of the liver:

1. **Hepatic artery:** gives off 2 terminal branches, one to each of the right and left lobes.
2. **Hepatic veins:** described before
3. **Portal vein:** described before

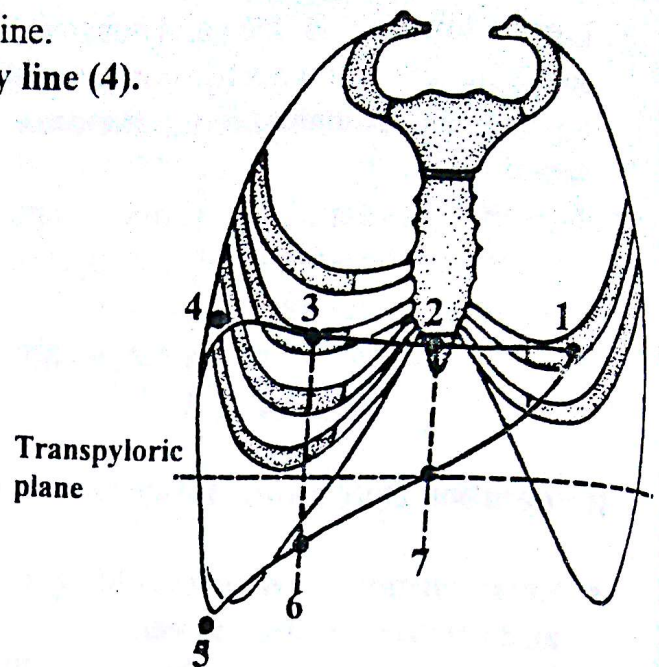
Factors maintaining the liver in its position

1. Peritoneal ligaments.
2. Connection of the 2 hepatic veins with inferior vena cava.
3. Areolar connective tissue between the liver and the diaphragm.
4. Intra-abdominal pressure which depends on the tone of the abdominal muscles.

Surface anatomy of the liver

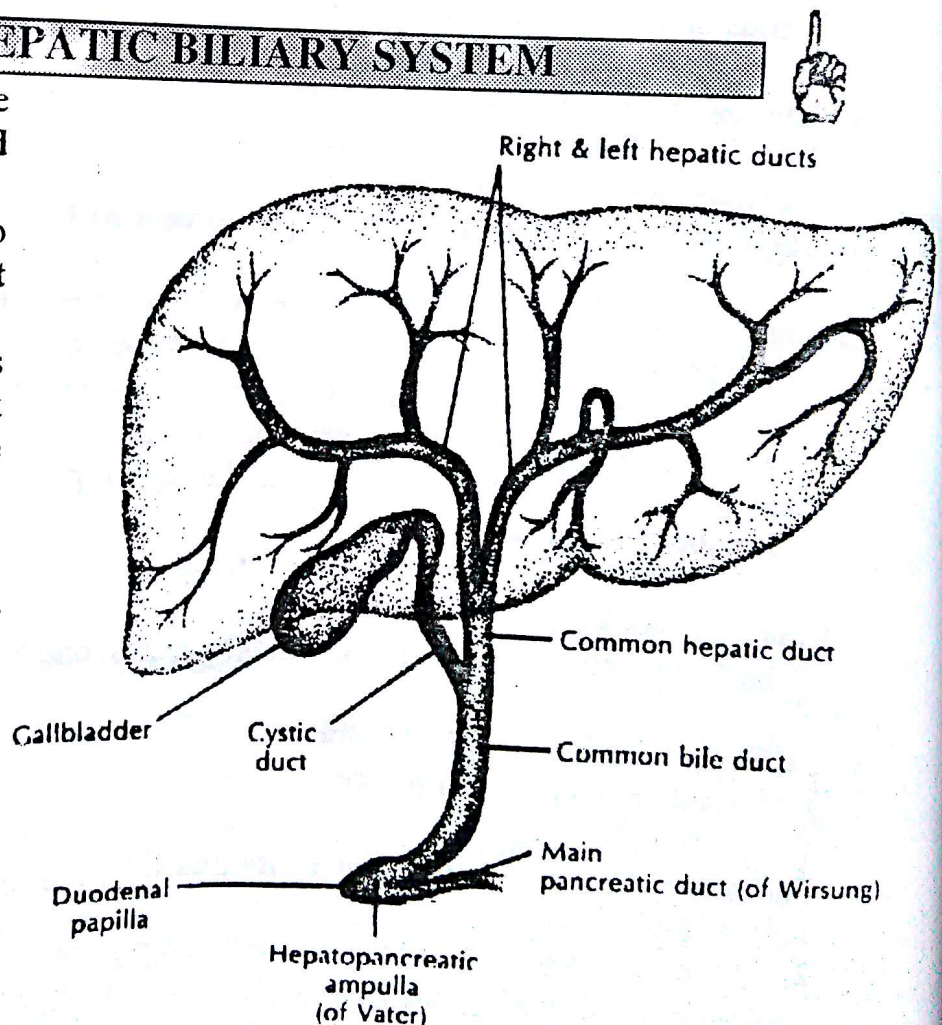
1. **Upper border:** is represented by a horizontal line passing through the following points:
 - **Point (1)** in the left 5th intercostal space 3 ½ inch from the median plane (apex of the heart).
 - **Point (2)** at the xiphisternal joint: in the median plane.

- **Pont (3)** at the right 5th rib: in the mid-clavicular line.
 - **Point (4) at the Right 7th rib: in the mid-axillary line (4).**
 - 2. **Right border:** is represented by a vertical line drawn in the mid-axillary line, from the right end of the upper border (**point 4**) down to a **point 1 cm below the costal margin (point 5).**
 - 3. **Inferior border:** is represented by an oblique line drawn from the lower end of the right border (**point 5**) to the left end of the upper border (**point 1**).
 - This line crosses the right costal margin at the **tip of the 9th costal cartilage (point 6)**, then crossing the median plane in the **transpyloric plane (point 7)**, a hand's breadth below the xiphisternal joint.
 - Then the inferior border reach the left end of the superior border at the 5th intercostal space 3 ½ inch from the median plane (**point 1**).
- N.B: These 3 borders mark the outline of the anterior surface of the liver which is triangular in shape.



THE EXTRA HEPATIC BILIARY SYSTEM

- Each lobe of the liver gives rise to a **hepatic duct (right and left).**
 - The two hepatic ducts unite to form the **common hepatic duct** (about one inch in length).
 - The common hepatic duct unites with the cystic duct, usually at an acute angle, to form the **bile duct (common bile duct)** (about three inches long).
- The **common bile duct** descends in the free margin of the lesser omentum, then, **behind the first part of the duodenum.**
- The bile duct then, runs on the back of the head of the pancreas. Ultimately, it passed into the wall of duodenum where it **unites with the pancreatic duct to form the ampulla of vater.** The ampulla open in the second part of the duodenum.



* **Hepatic ducts:** A right and a left hepatic ducts emerge from the liver, one from each lobe.

- The 2 hepatic duct are the most anterior structure in the porta hepatis.
- They unite to form the common hepatic duct.

* **Common hepatic duct:** a short duct, about one inch or more in length.

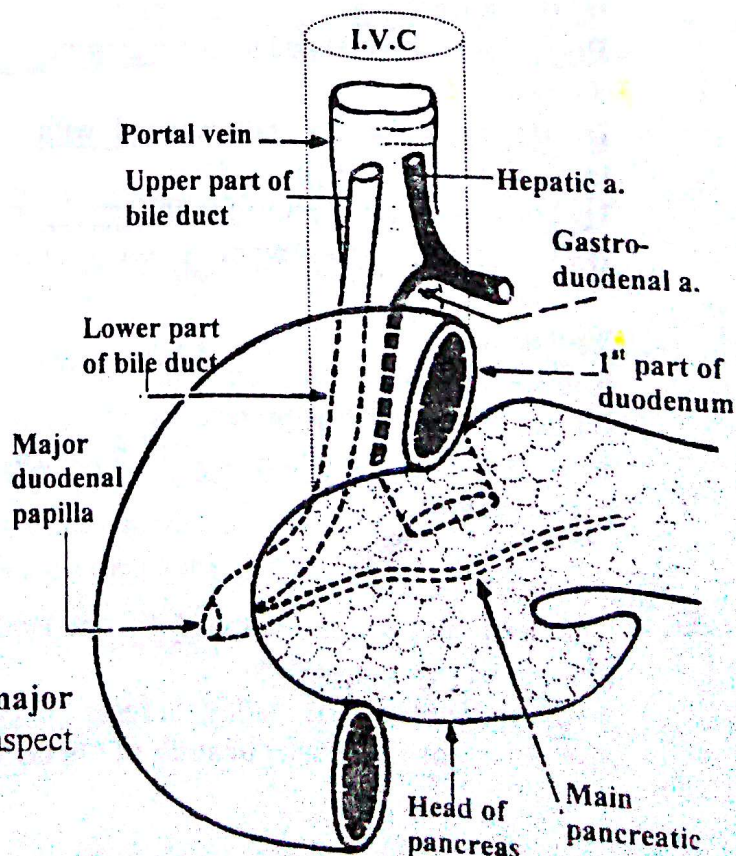
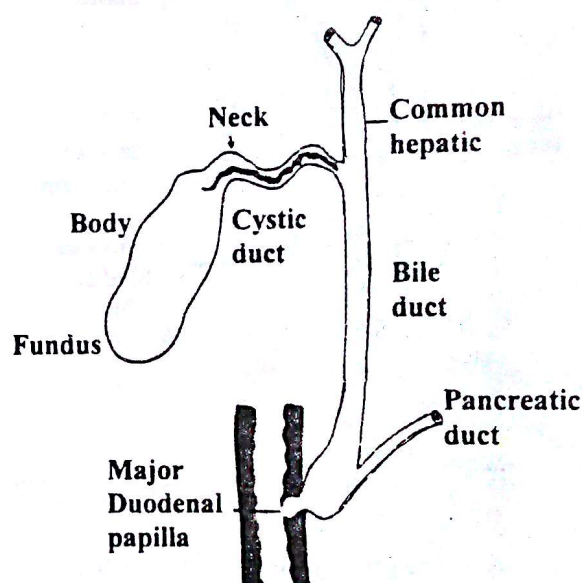
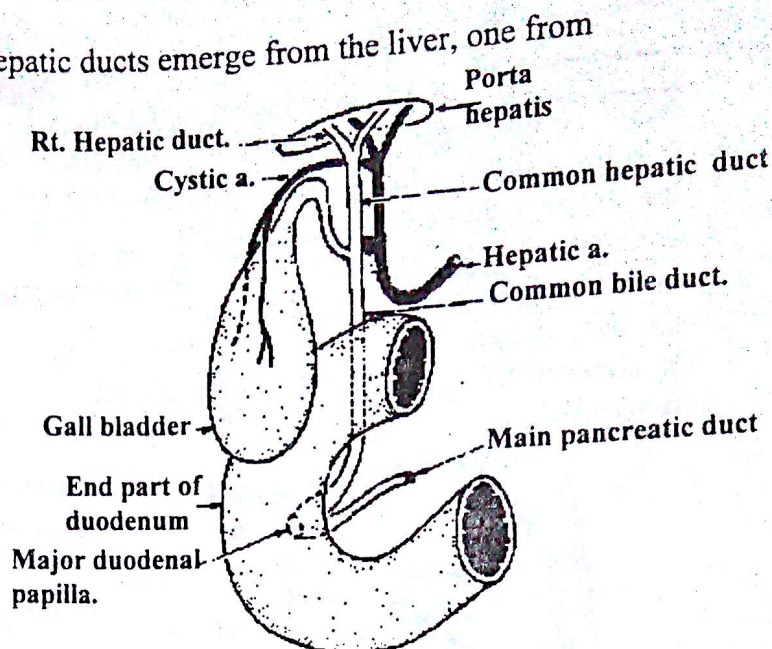
- It descends **infront of the portal vein** and on the **right side of the hepatic artery**.
- It joins the cystic duct at an acute angle to form the bile duct.

* **Cystic duct:** about one and half inches long.

- It is usually S-shaped. Its mucosa form a **spiral valve**.
- The cystic duct joins the common hepatic duct at an acute angle to form the common bile duct.

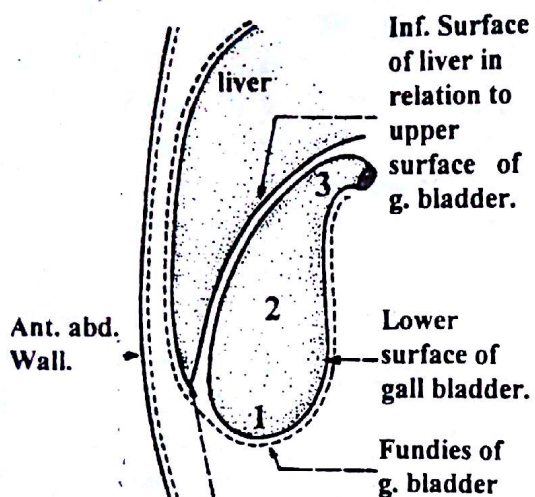
* **Common bile duct:** formed by the union of the cystic and common hepatic ducts.

- It is about **three inches long**. Where it lies **infront of the portal vein**.
- It descends in the **free margin of the lesser omentum** anterior to the portal vein and on the **right side of the hepatic artery**.
- Then, it descends **behind the first part of the duodenum**.
- It then **runs in a groove on the back of the head of the pancreas** and here it lies **infront of the I.V.C.**
- The **terminal part of the bile duct** runs along the right side of the main pancreatic duct.
- The 2 ducts passes into the wall of the duodenum where they unit to form the **hepato-pancreatic ampulla (ampulla of Vater)**.
- The ampulla opens on the summit of the **major duodenal papilla** on the **postero medial aspect of the 2nd part of the duodenum**.

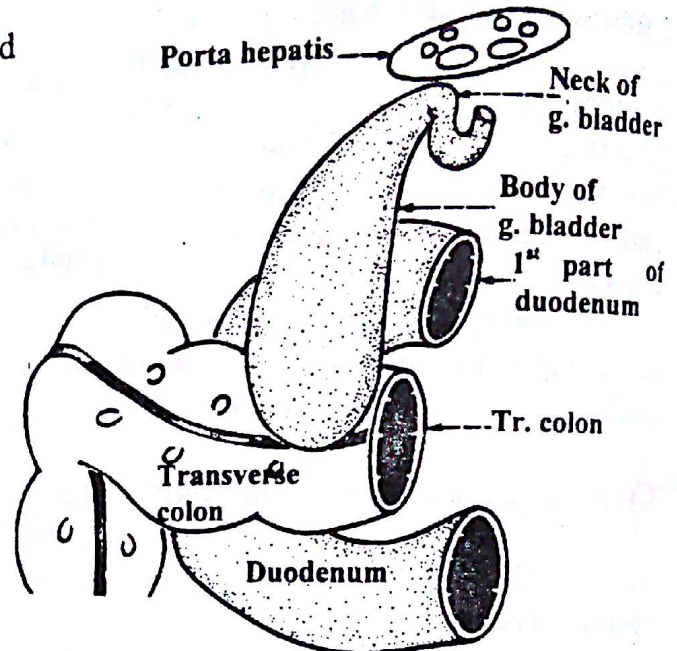
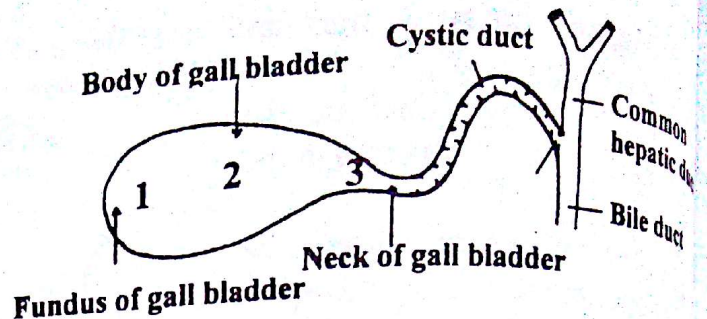


Gall bladder:

- An elongated (8-10 cm in length, 3 cm in width) pear-shaped sac which lies on the inferior surface of the right lobe of liver.
- Its lower surface and sides are covered with peritoneum; while its upper surface is directly adherent to the liver tissue.
- It consists of a fundus (1), body (2) and neck (3).



Gall bladder – relations of the upper surface



Gall bladder – relations of the lower surface

The fundus:

- Is completely covered with peritoneum, as it projects beyond the inferior border of the liver.
- **Anteriorly:** comes into contact with the anterior abdominal wall close to the tip of the right ninth costal cartilage.
- **Posteriorly:** it is related to the beginning of transverse colon.

The body.

Its upper surface is not covered with peritoneum and is in contact to the inferior surface of liver.

Its lower surface is related to the transverse colon, and the termination of the first part and beginning of the second part of the duodenum.

The neck.

- It is the narrow twisted part which follows the body.
- Its mucous membrane projects inside the lumen forming a spiral valve.
- It is continuous with the cystic duct and both together form and S shaped arrangement.

Blood supply

- The gall bladder is supplied by the cystic artery which arises from the right branch of hepatic artery.
- Veins draining of the bladder is form 1-2 cystic veins which either enter the liver directly or join the right branch of portal vein.

Surface anatomy of the gall bladder

- * The **fundus of gall bladder** projects beyond the inferior border of the liver to come in **direct contact with the anterior abdominal wall**.
- * It is marked by a point close to the **tip of the right 9th costal cartilage**.
- **This point lies on the transpyloric plane where the latter cuts costal margin.** It lies at the upper end of the **linea semilunaris**.



Tip of the Rt. ninth costal cartilage

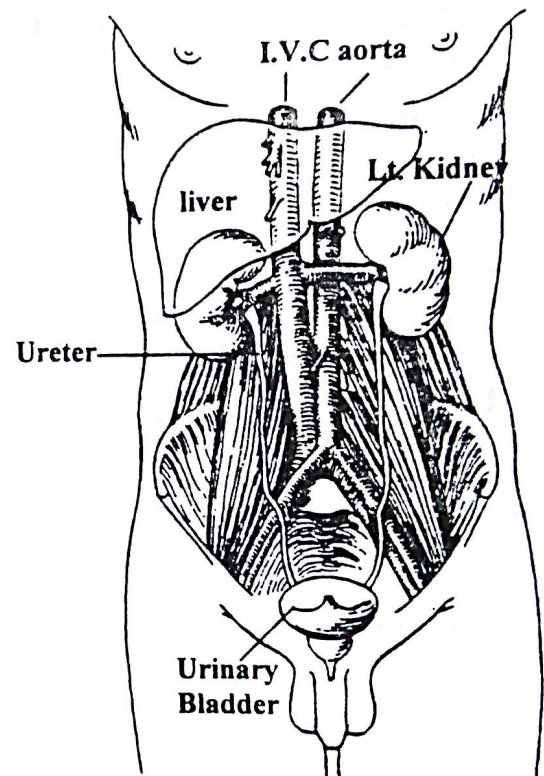
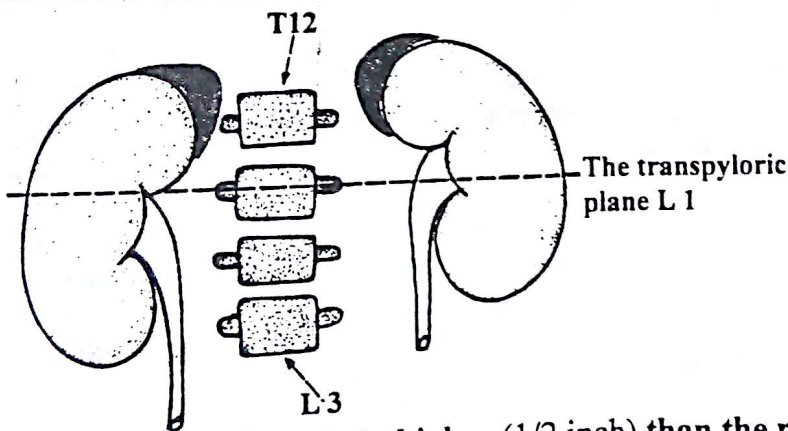
Linea semilunaris

Transpyloric plane (L.1)

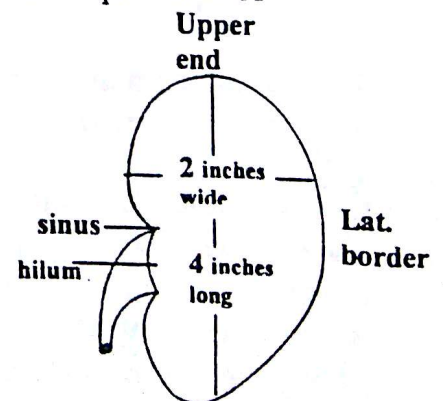
Fundus of gall bladder

KIDNEY

- * The kidneys lie on the posterior abdominal wall, one on each side of the vertebral column, behind the peritoneum.
- * Each kidney extends opposite the **12th thoracic** and **upper 3 lumbar vertebrae**, with its long axis directed downwards and laterally.
- * The **transpyloric plane (L.1)** passes through the upper part of the right hilum, but through the lower part of the left hilum.



- * The **left kidney is slightly higher (1/2 inch) than the right** due to the presence of the liver on the right side.
- The left kidney reaches posteriorly up to the 11th rib, while the right kidney reaches up to the 11th space.
- * Each kidney is **about 4 inches long, 2 inches wide and 1 inch thick**.
- Each kidney has **2 borders** (medial and lateral), **2 surfaces** (anterior and posterior) and **2 ends** (upper and lower).
- * The **hilum** of the kidney lies on the medial border, and this hilum leads to a space inside the kidney named the **renal sinus**. The renal sinus is lined by an extension of the fibrous capsule of the kidney, and lodges the pelvis of the ureter and the renal vessels.

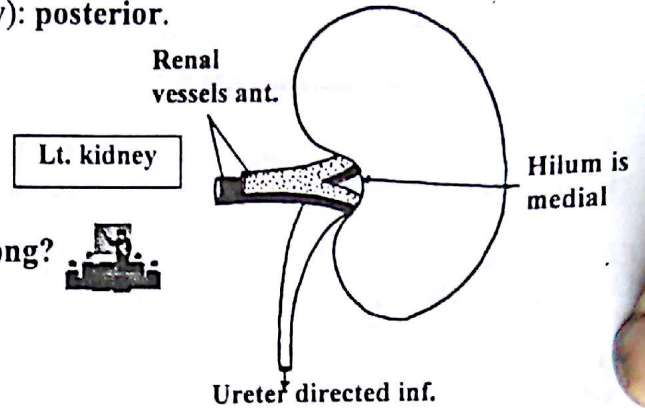
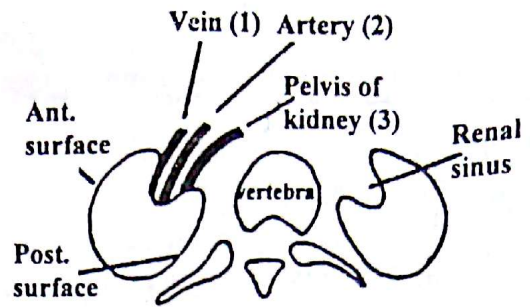


* The hilum gives passage to the renal vessels and nerves, and the pelvis of the ureter.

* The structures in the hilum are arranged as follows:

- Renal vein (1): anterior,
- Renal artery (2): Intermediate and
- Pelvis of the ureter (3) (pelvis of the kidney): posterior.

N.B: Sinus of the kidney: is a central recess within the kidney which is occupied by the calices, pelvis of the ureter and the renal vessels.



How to identify to which side the kidney belong?

- Hilum is medial in position.
- Renal vessels are anterior to the pelvis.
- Ureter is directed inferiorly.

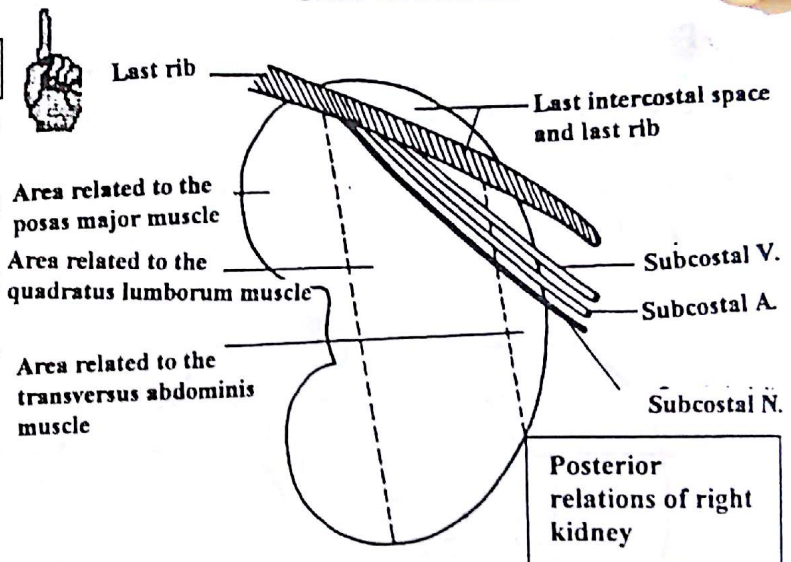
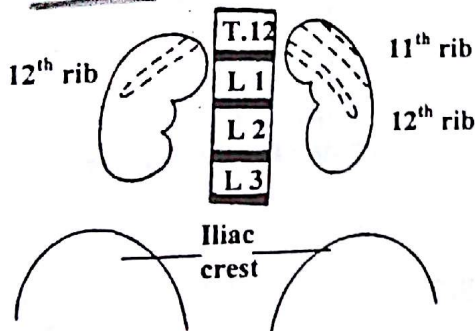
Posterior relations of the kidney:

The posterior surface of the kidney has no peritoneal covering.

- It is related directly to the following structures:

1. **Diaphragm:** related to the upper part of its posterior surface.

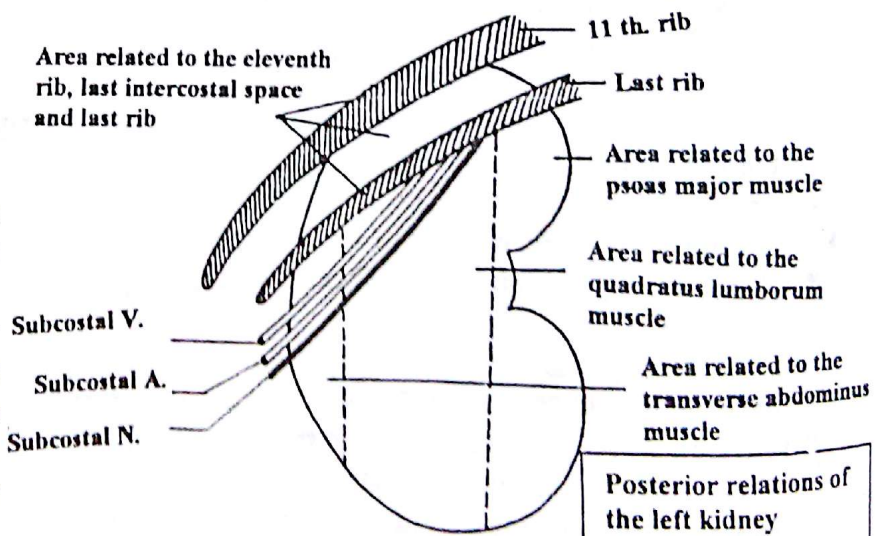
The diaphragm separates the kidney from the pleura.



- The diaphragm also separates the right kidney from the last (12th) rib.

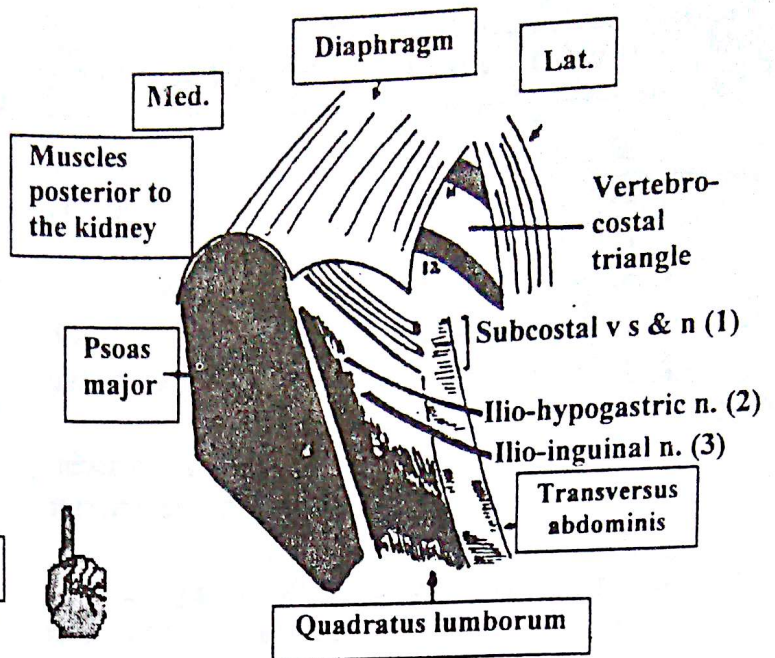
- It separates the left kidney from the last rib, last intercostal space and the lower border of the 11th rib; because the left kidney is higher than the right.

2. **Psoas major muscle:** related to the posterior surface close to the medial border of the kidney and below the diaphragmatic area.
3. **Quadratus lumborum muscle:** related to the intermediate part of the posterior surface lateral to the psoas major and below the diaphragm.



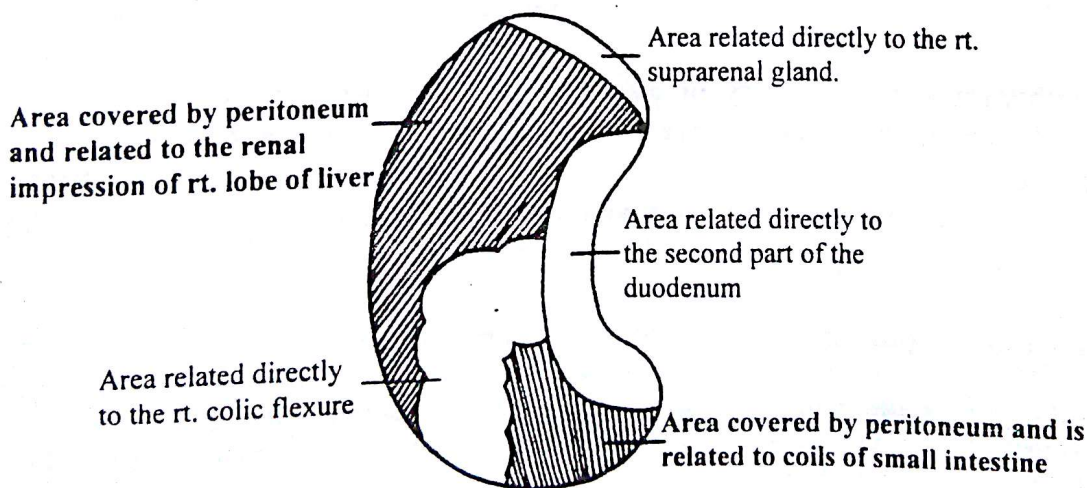
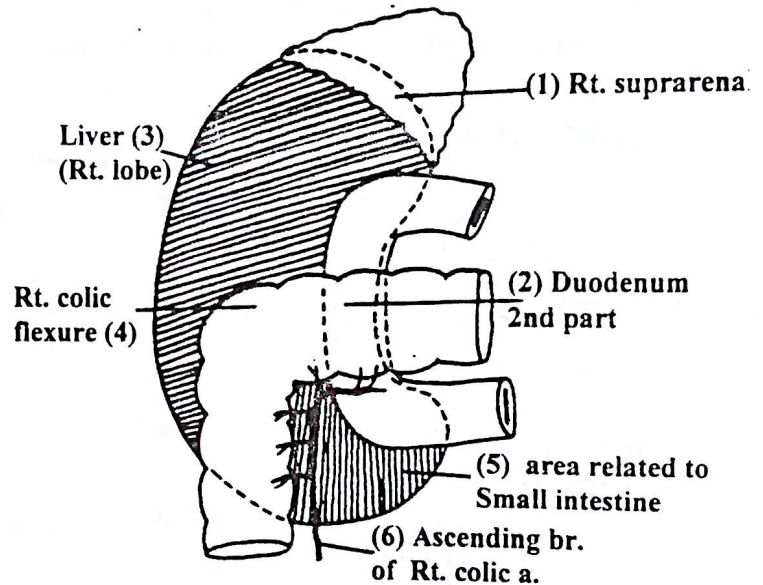
- * The kidney is separated from the quadratus lumborum by: the subcostal vessels, subcostal nerve (1), iliohypogastric nerve (2) and ilioinguinal nerve (3) arranged successively from above downwards.

4. **Transversus abdominis:** it is related to the posterior surface of the kidney close to its lateral border and below the diaphragm.



Anterior relations of the right kidney:

- The anterior surface of the right kidney has a partial covering of peritoneum.
- It is related to the following viscera:
 1. **Suprarenal gland:** at the upper end and upper part of the medial border.
 2. **Second part of the duodenum:** close to the medial border and the hilum.
 3. **Right lobe of the liver (renal impression):** related to a large area lateral to the second part of the duodenum.
 4. **Right colic flexure:** related to the lower and lateral part.
 5. **Coils of small intestine:** related to the lower and medial part. This part is also related to the ascending branch of the right colic artery (6).

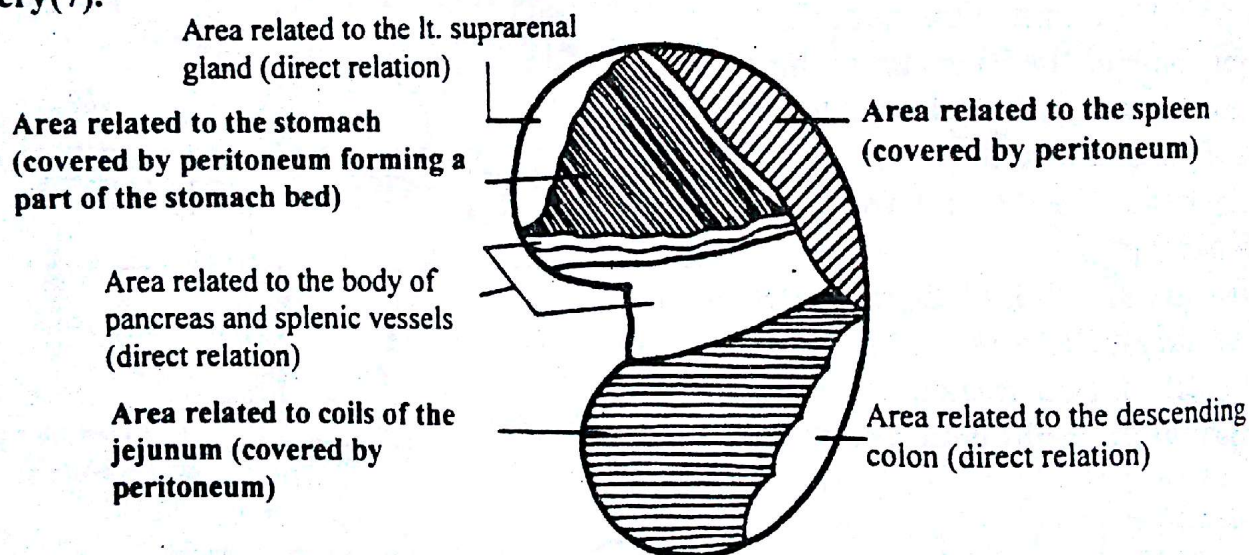
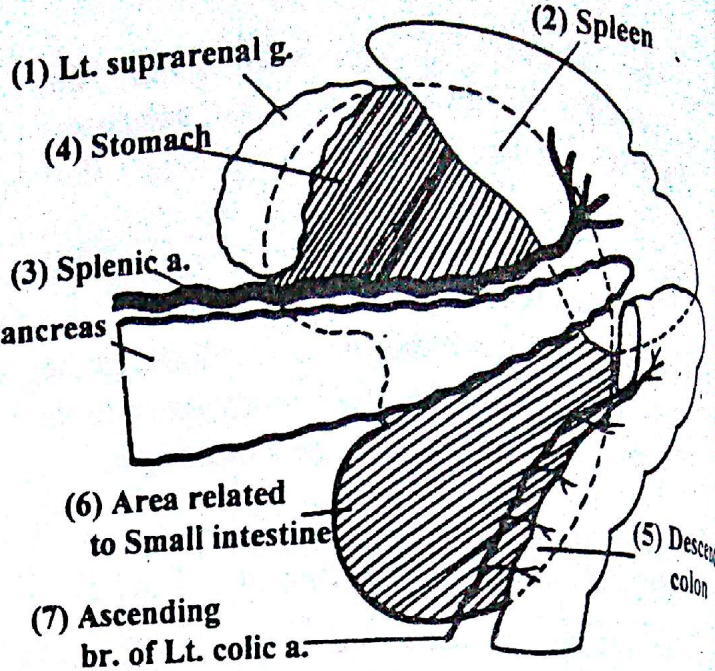


- The **suprarenal gland, duodenum** and **right colic flexure** lie directly in front of the right kidney. Their areas on the kidney are not covered with peritoneum.
- The areas related to the **liver** and **small intestine** are covered with peritoneum.

Anterior relations of the left kidney:

The anterior surface of the left kidney has a partial covering of peritoneum and is related to the following viscera:

1. **Suprarenal gland:** close to the upper part of the medial border.
2. **Spleen:** related to the part close to the upper part of the lateral border.
3. **Body of pancreas and splenic vessels:** related to the middle part of the anterior surface.
4. **Stomach:** related to the triangular area between the suprarenal, splenic and pancreatic areas.
5. **Descending colon:** related to an area close to the lower part of the lateral border.
6. **Small intestine:** related to the lower and medial part. This part is also related to the ascending branch of the superior left colic artery(7).



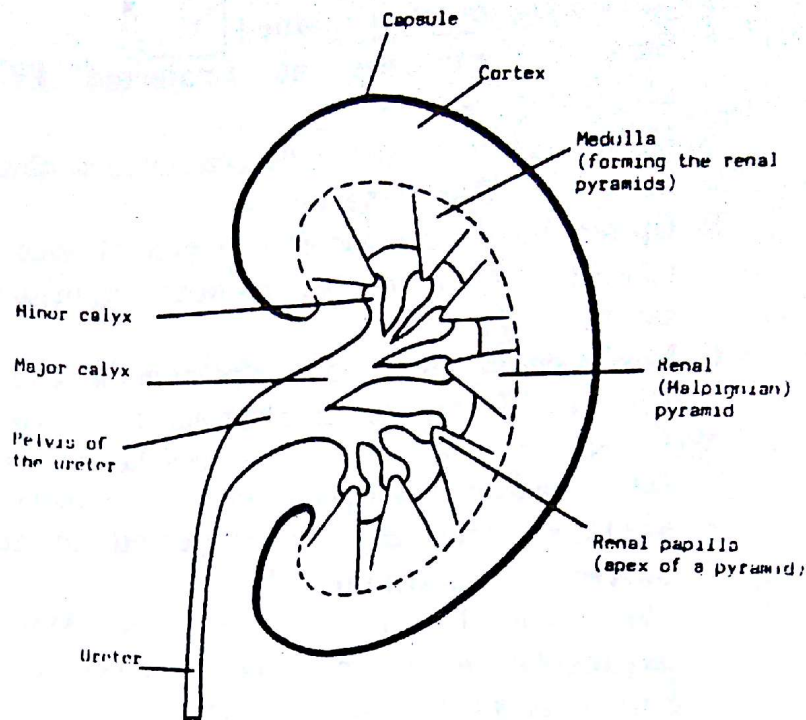
- The suprarenal gland, body of pancreas and descending colon lie directly in front of the kidney. Their areas on the kidney are not covered with peritoneum.
- The areas related to spleen, stomach and small intestine are covered with peritoneum.

* Kidney in a longitudinal section (the figure in page 77):

- The kidney is surrounded by a thin fibrous capsule.
- The kidney tissue is differentiated into an outer cortex and an inner medulla.
- The cortex lies under the capsule. The cortical tissue also extends in between the pyramids of the medulla to form the renal columns.
- The medulla is composed of 10-18 conical masses which are called the renal pyramids or malpighiati pyramids.
- The bases of the pyramids are directed towards the renal cortex, while their apices are directed towards the renal sinus.
- The apices of the pyramids are known as the renal papillae, and are surrounded by the beginning of the minor calices.

Pelvis of the ureter (renal pelvis): a dilated sac which occupies the renal sinus. It extends outside the hilum to become continuous with the ureter.

- Inside the kidney sinus, the pelvis divides into two (sometimes three) major calices.
- Each **major calyx** divides into several minor calices.
- The **minor calices** are 10-12 in number.
- Each terminates by surrounding one or more of the renal papillae.



Covering of the kidney



The kidney is surrounded by several layers, which are arranged as follows from within outwards:

1. Fibrous capsule: ←

It closely surrounds the kidney, and forms the innermost coat.

2. Perirenal (perinephric) fat: ←

It lies just to the outside of the capsule.

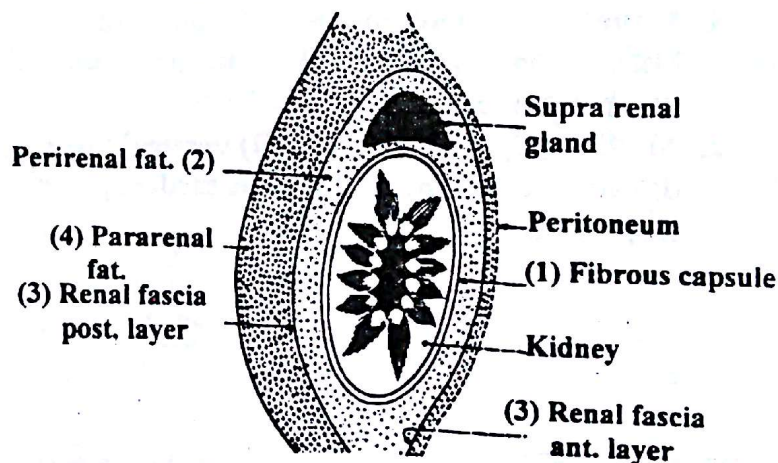
3. Renal fascia: ←

* It lies to the outside of the perirenal fat and extends upwards to surround also the suprarenal gland.

* It consists of 2 layers (anterior and posterior) which are fused together above suprarenal gland and at the lateral and medial borders of the kidney. However, the 2 layers remain separate below and extend as separate layers down to iliac fossa.

4. Pararenal (paranephric) fat: ←

It is a large mass of fat situated outside renal fascia especially behind the kidney.



Factors fixing the kidney in place:



1. Attachments of the renal fascia to the capsule of the kidney by numerous trabeculae which traverse the perirenal fat. This fascia is also attached to the following structures outside the kidney:
Upwards: attached to the diaphragmatic fascia.
Medially: attached to the psoas fascia.
2. Apposition of neighboring viscera.

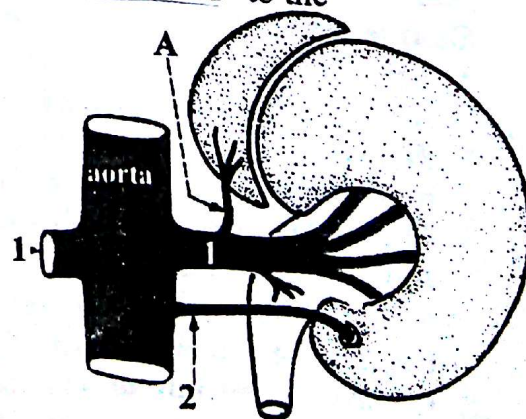
Arteries of the kidney:

* Renal artery (1):

- It arises from the side of the abdominal aorta opposite the upper border of the 2nd L.V.
- Each artery gives suprarenal branch (A)

* Accessory renal artery (2):

- It may be found in 30% cases. It arises from the aorta just above or just below the renal artery. It commonly enters the upper or lower pole of the kidney.



Surface anatomy of the kidney



* **Surface anatomy as projected to the anterior abdominal wall:**

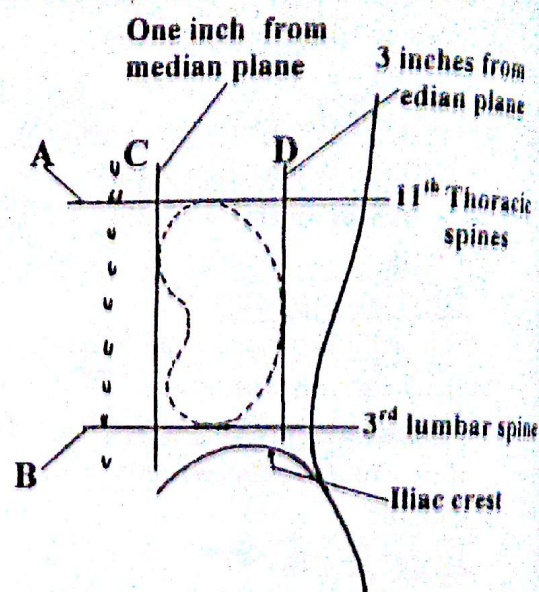
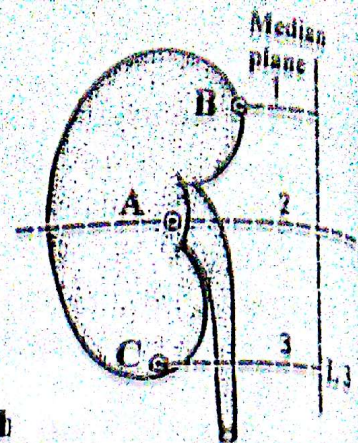
- Hilum:** Its center lies in the transpyloric plane (L.1), 2 inches from the median plane.
- Upper end:** corresponds to a point 1 inch from the median plane (on a line midway between transpyloric plane and xiphi sternum).
- Lower end:** corresponds to a point in the subcostal plane opposite the 3 inches from the median plane and 2 inches below the hilum.

N.B.: Note that the long axis of the kidney lies obliquely downwards and laterally where the upper end lies 1 inch, the hilum 2 inches and the lower end 3 inches from the median plane.

* **Surface anatomy as projected to the posterior abdominal wall:**

- The kidney lies in a rectangle called **Morris parallelogram**, down on the back between 2 horizontal and 2 vertical lines, as follows:

- Upper (A) and lower (B) horizontal lines:** drawn opposite the 11th thoracic and 3rd lumbar spines respectively.
- Medial (C) and lateral (D) vertical lines:** drawn 1 and 3 inches from the median plane respectively.



URETERS

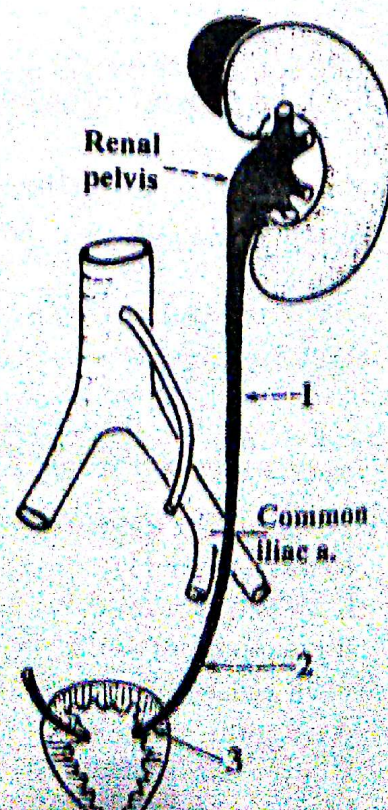
The **ureter** is 10 inches (25cm) long, with its upper ½ situated in the abdomen proper and its lower ½ in the pelvis.

Parts of the ureter:

- Abdominal (1).**
- Pelvic (2)** (after it crosses the common iliac artery).
- Intrameural (3)** (embedded in the wall of the urinary bladder)

Course of the abdominal part of the ureter.

- * The ureter begins inside the sinus of the kidney in the form of a dilated part called the **renal pelvis**.
- * The renal pelvis become continuous with the ureter proper opposite the lower end of the kidney.
- * The ureter descends with a slight medial inclination on the **anterior surface of the psoas major**, directly behind the peritoneum and opposite the tips of the lumbar transverse processes.
- * It crosses in front of the end of the common iliac artery or the beginning of the external iliac artery to enter the pelvis.



Relations of the abdominal part of the ureter

Posterior relations of the 2 ureters:

1. Psoas major.
2. Psoas minor.
3. Genitofemoral nerve (crosses behind the ureter).
4. End of the common iliac artery or beginning of the external iliac artery.

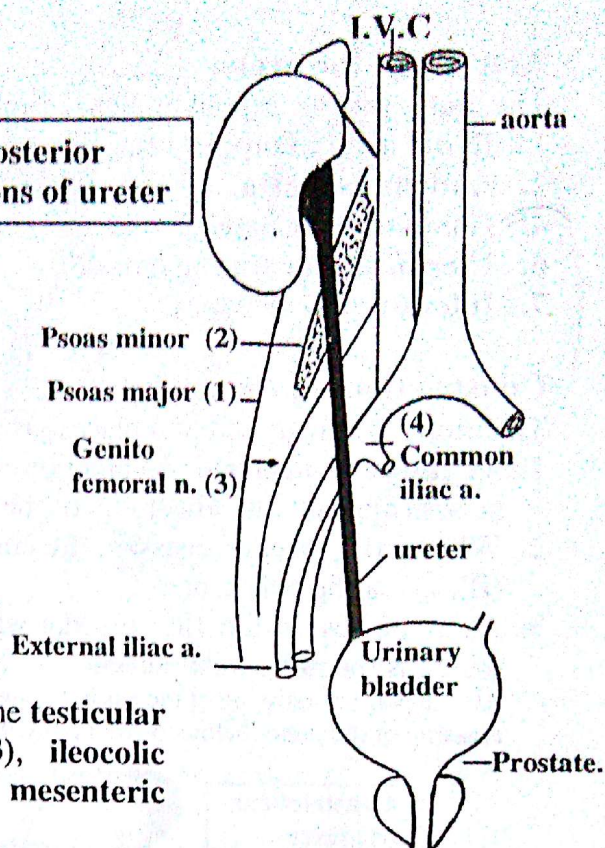
N.B: The I.V.C runs medially parallel to the right ureter.

Anterior relations

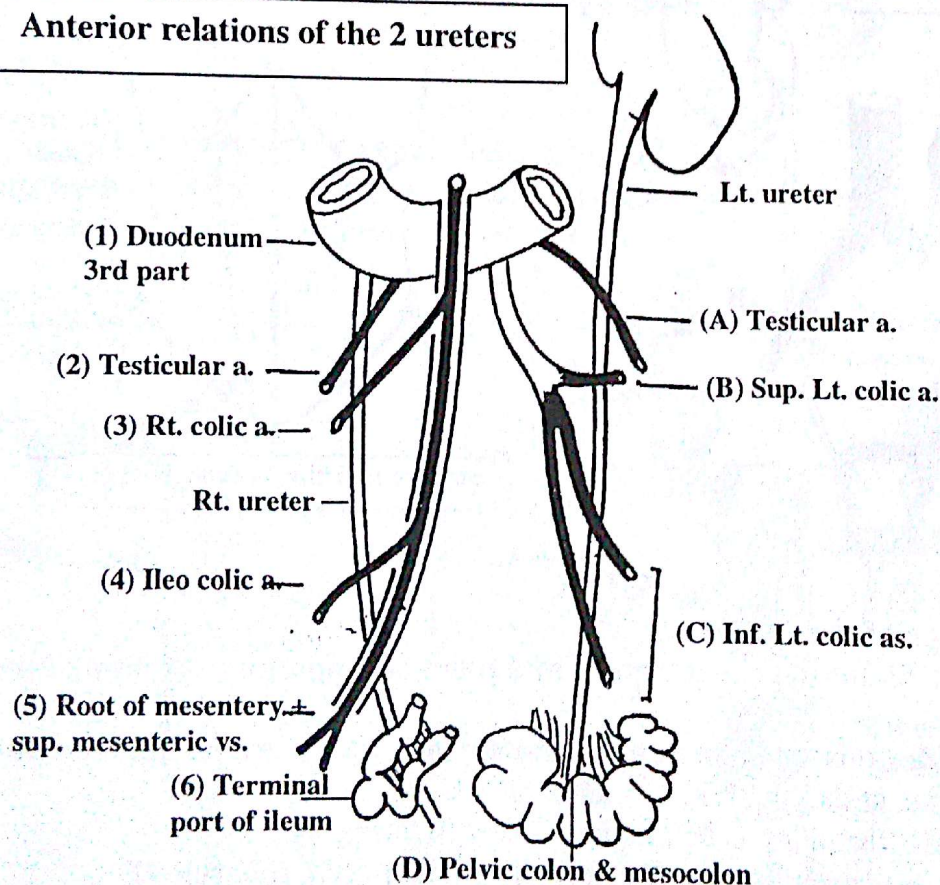
Right ureter:

- Descends behind the peritoneum of the posterior abdominal wall in front of the psoas major muscle, opposite the tip of the lumbar transverse processes.
- It descends on the right side of the inferior vena cava.
- Its uppermost part is covered by the **third part of the duodenum (1)**.
- As the ureter descends it is **crossed anteriorly** by the testicular or ovarian vessels (2), right colic vessels (3), ileocolic vessels (4), root of the mesentery & superior mesenteric vessels (5) and terminal part of the ileum (6).

Posterior relations of ureter



Anterior relations of the 2 ureters



Left ureter:

- Descends behind the peritoneum of the posterior abdominal wall in front of the psoas major muscle, opposite the tip of the lumbar transverse processes.
- It is **crossed anteriorly** by the left testicular or ovarian vessels (A) the superior (B) and inferior left colic vessels (C).
- Its lower part is crossed by the **pelvic colon and its mesocolon (D)**.
- The abdominal part of the ureter on each side leaves the pelvis by crossing the end of the common iliac or the beginning of the external iliac artery.

Arteries of the ureter



The ureter gets its arterial branches from:

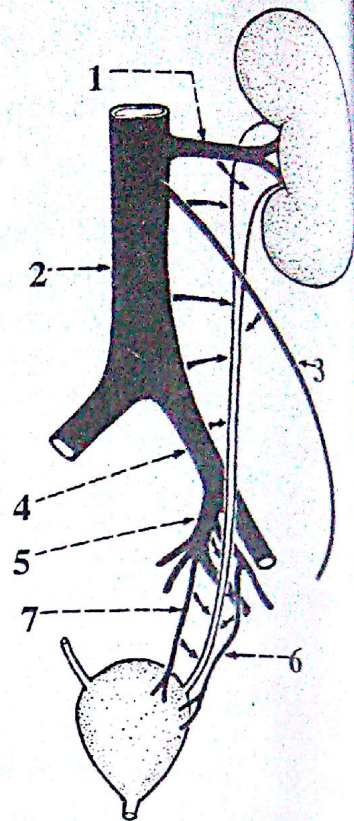
1. Renal artery (supplies the renal pelvis).
2. Abdominal aorta.
3. Gonadal artery.
4. Common iliac artery.
5. Internal iliac artery.
6. Uterine artery (in the female).
7. Inferior vesical artery.

Constrictions of the ureter

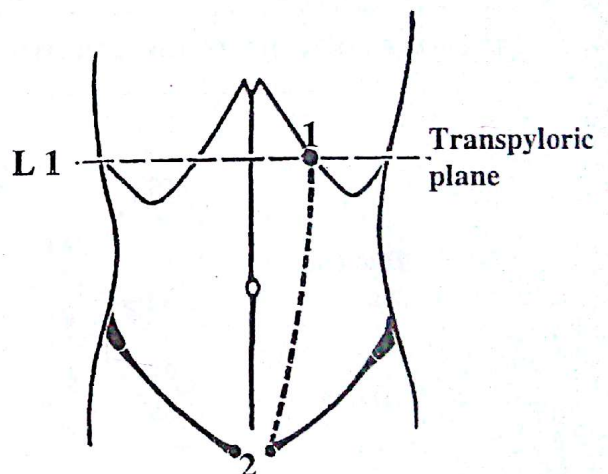
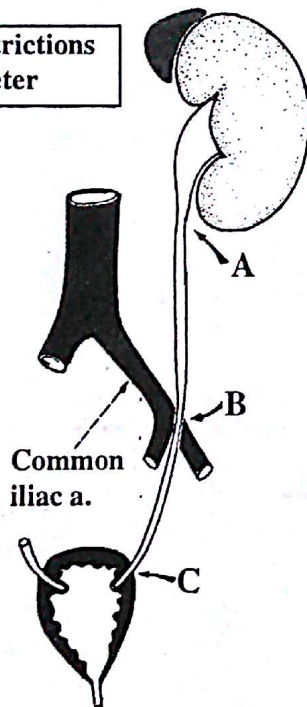


The ureter is constricted at 3 places, as follows:

1. At the **pelvi-ureteric (A)** junction, where the ureter joins the renal pelvis (opposite the lower end of the kidney).
2. Where the ureter crosses the end of the common iliac artery (B), i.e. at the pelvic brim.
3. As it passes inside the bladder wall, i.e. its **intramural part (C)** which is the narrowest portion.
4. At the point of crossing of the vas deferens over the ureter in male & at point of crossing of the ureter below the root of the broad ligament in female.



Constrictions of ureter



Surface markings of the ureter:

Surface markings of the ureter:



- The upper end of the ureter is marked by a point (1) opposite the hilum of the kidney.
- On the left side, this point lies on the transpyloric plane two inches from the median plane, i.e. at the tip of the left ninth costal cartilage.
- On the right side, the hilum is half an inch lower to this point.
- The line of the ureter extends from this point down the public tubercle (2).

Suprarenal glands

Position, shape and size:

- * The suprarenal gland is situated on the upper pole of the kidney.
- * It is surrounded by pre-renal fat within the renal fascia.
- The right gland is pyramidal in shape, while the left gland is semi lunar.

Relations Of The Suprarenal Gland:

Relations of the right gland:

* Anterior relations:

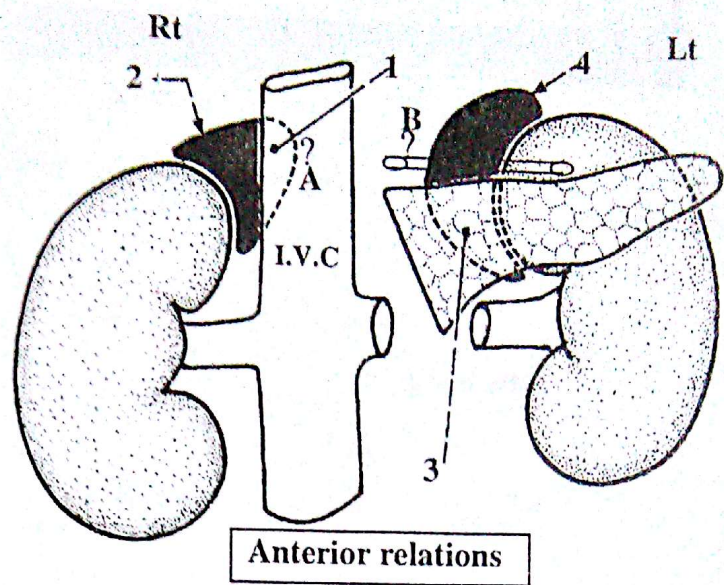
- 1) I.V.C: medially (1).
- 2) Right lobe of the liver: laterally (2).

* Posterior relations:

- 1) Diaphragm: above.
- 2) Upper pole of the right kidney: below.

* Medial relations:

- 1) Right inferior phrenic artery: above.
- 2) Right coeliac ganglion (A): below.



Relations of the left gland:

* Anterior relations:

- 1) Lesser sac and stomach (3): above, (the gland forms a part of the stomach bed).
- 2) Pancreas (4) and splenic artery (5): below.

* Posterior relations:

- 1) Left kidney: laterally.
- 2) Left crus of the diaphragm: medially.

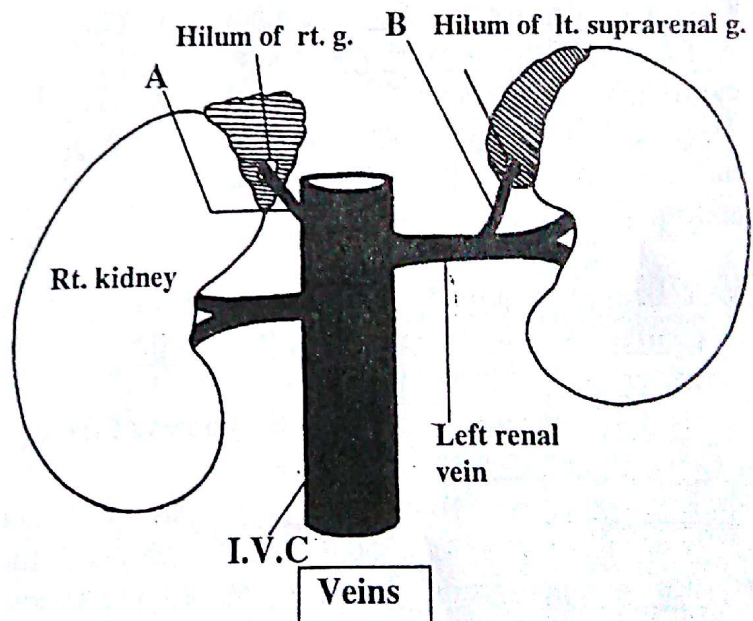
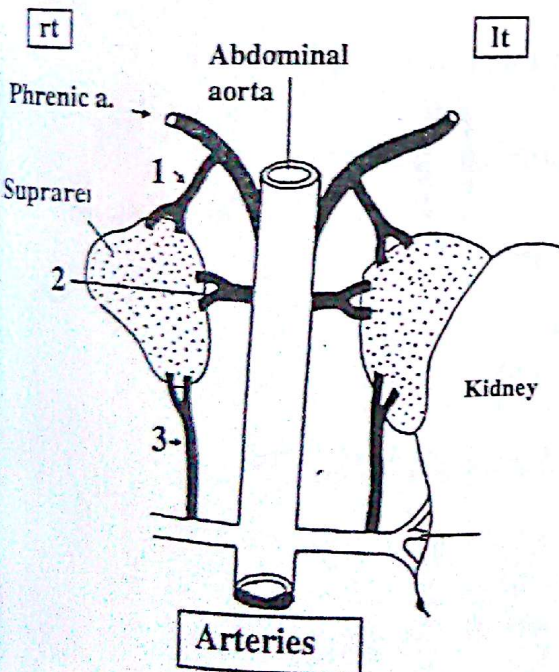
* Medial relations:

- 1) Left inferior phrenic artery: above.
- 2) Left coeliac ganglion (B): below.

Blood supply:

* Arteries:

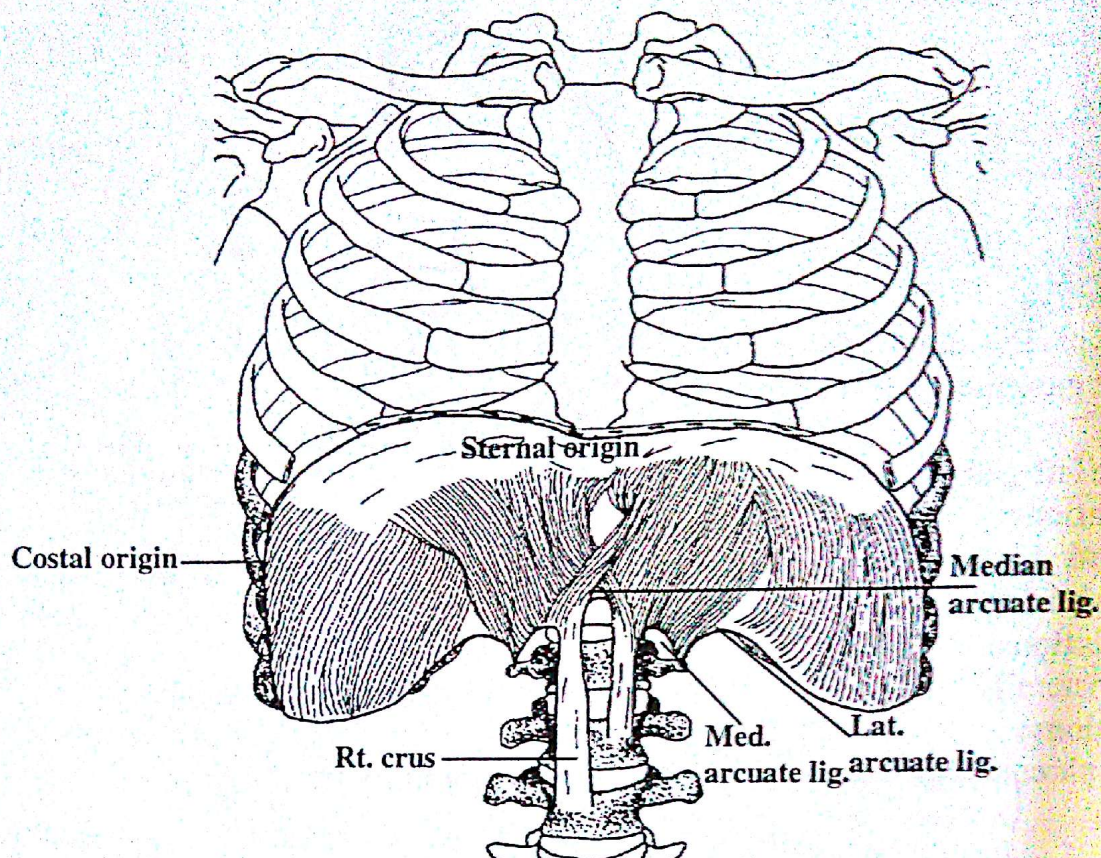
- 1) Superior suprarenal artery (1): from the inferior phrenic artery.
- 2) Middle suprarenal artery (2): from the abdominal aorta.
- 3) Inferior suprarenal artery (3): from the renal artery



* Veins:

- 1) Right suprarenal vein (A): ends in the inferior vena cava.
- 2) Left suprarenal vein (B): ends in the left renal vein.

DIAPHRAGM



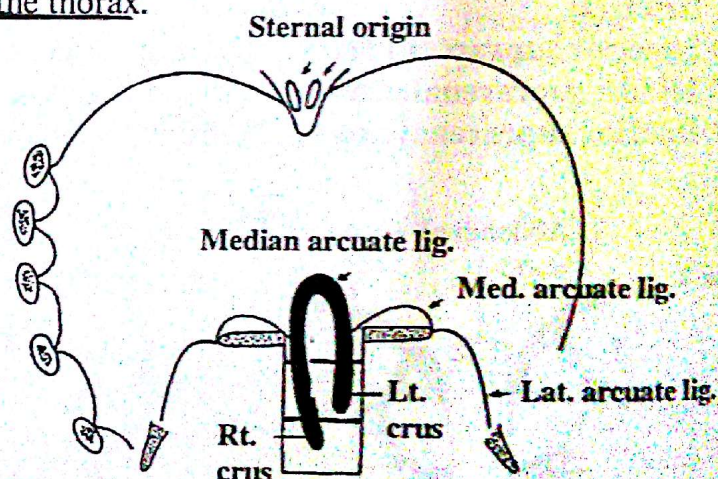
Origin: from the circumference of the outlet of the thorax.

This origin is divided into three parts:

- a. **Sternal origin:** by two slips from the back of the xiphoid process.

- b. **Costal origin:** by slips from the inner surface of the lower six costal cartilages, on each side.

These slips interdigitate with the slips of origin of the transversus abdominis.



- c. **Vertebral origin:** from the lumbar vertebrae, by the crura and arcuate ligaments.
1. **Crura:** The right crus is larger than the left; and arises from the bodies of the upper three lumbar vertebrae.
- The left crus arises only from the bodies of the upper two lumbar vertebrae.

- ## 2. Arcuate ligaments:

- **Median arcuate ligament:** a tendinous arch which connects the two crura in front of the descending aorta at the level of the border of the last thoracic vertebra.
 - **Medial arcuate ligament:** a tendinous arch (one on each side) which connects the crus with the tip of the transverse process of the first lumbar vertebra in front of the psoas major muscle.
 - **Lateral arcuate ligament:** a tendinous arch (one on each side) which connects the tip of the transverse process of the first lumbar vertebra with the last rib in front of the quadratus lumborum muscle.
- The fibers converge from their origin to be inserted into the central tendon of the diaphragm.

Insertion:

The diaphragm has no bony insertion, but all the fleshy fibers are inserted into the central tendon which is adherent to the pericardium.

The central tendon is semi lunar in shape with its concavity directed backwards.

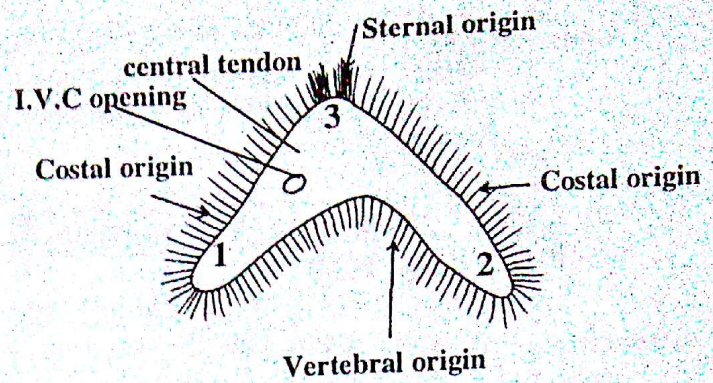
- It is divided into three lobes or leaflets by slight indentations.

- The lateral parts form the right (1) and left (2) lobes or horns.

- The median part (3) is called the median lobe, and is the widest part of the central tendon.

* The central part of the diaphragm is depressed inferiorly than the lateral parts which are called cupula.

- The right cupula reaches at a slightly higher level than the left one, owing to the upward bulge of the right lobe of the liver.



Relations:

Superiorly:

- The right cupula (1) is related to the right pleura and base of the right lung (A).

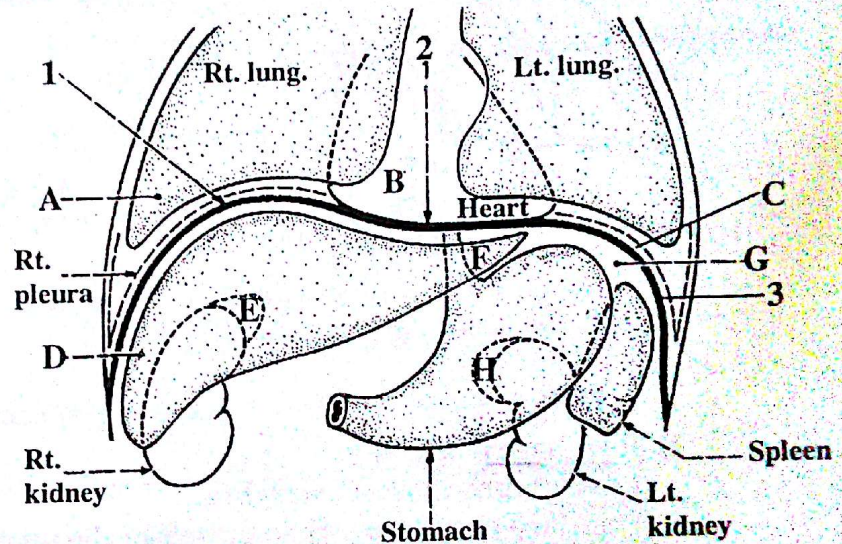
- The median lobe (2) of the central tendon is related to the pericardium and the heart (B).

- The left cupula (3) is related to the left pleura and base of the left lung (C).

Inferiorly:

- The right cupula (1) is related to the right lobe of the liver (D), right kidney and right suprarenal gland (E).

- The left cupula (3) is related to the left lobe of the liver (F), fundus of the stomach (G), spleen, left kidney and left suprarenal gland (H).



Arterial supply:

Phrenic arteries:

Superior phrenic (A) (from descending thoracic aorta)

Inferior phrenic arteries (B) (from abdominal aorta).

2 Musculo-phrenic (C) arteries.

3 Pericardiaco-phrenic (D) arteries.

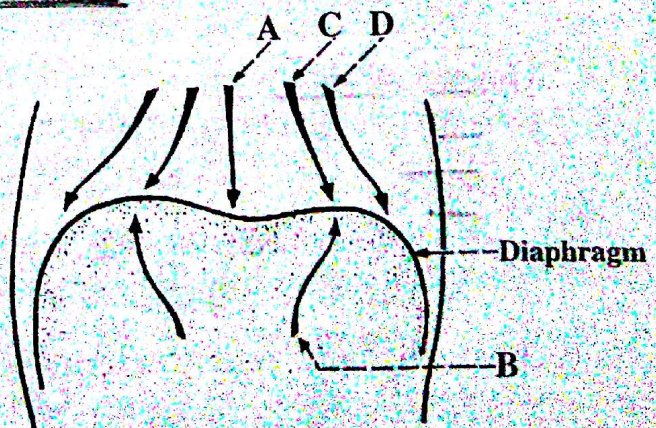
4 Twigs from the lower intercostal arteries.

5 Twigs from the descending thoracic aorta.

Nerve supply: Phrenic nerves (C, 3, 4, 5).

The phrenic nerves pierce and ramify on its inferior surface.

Sensory fibers from the lower six intercostal nerves supply the of the diaphragm.



Actions: The diaphragm is called into action during:

1. **Inspiration:** the diaphragm being the chief muscle of inspiration.
2. **Forced expiration or expulsive acts:** defecation, urination, parturition, vomiting and coughing.

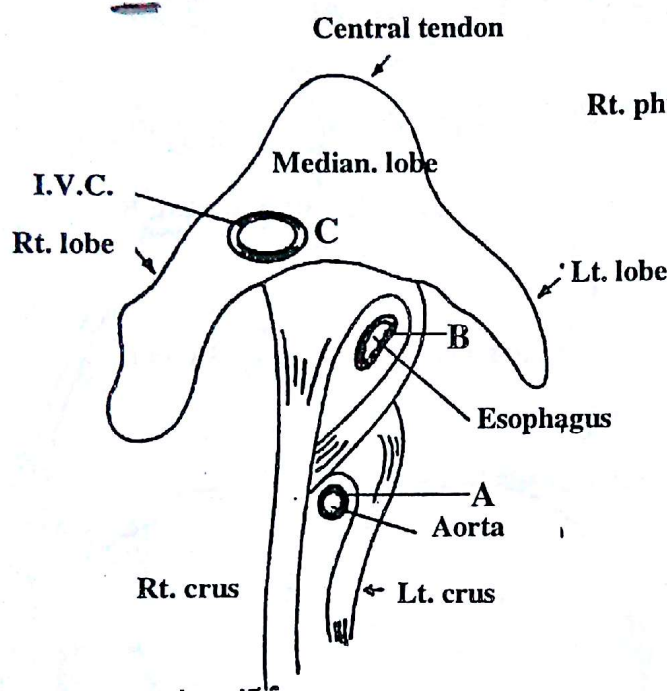
Major openings in the diaphragm

A. Aortic opening:

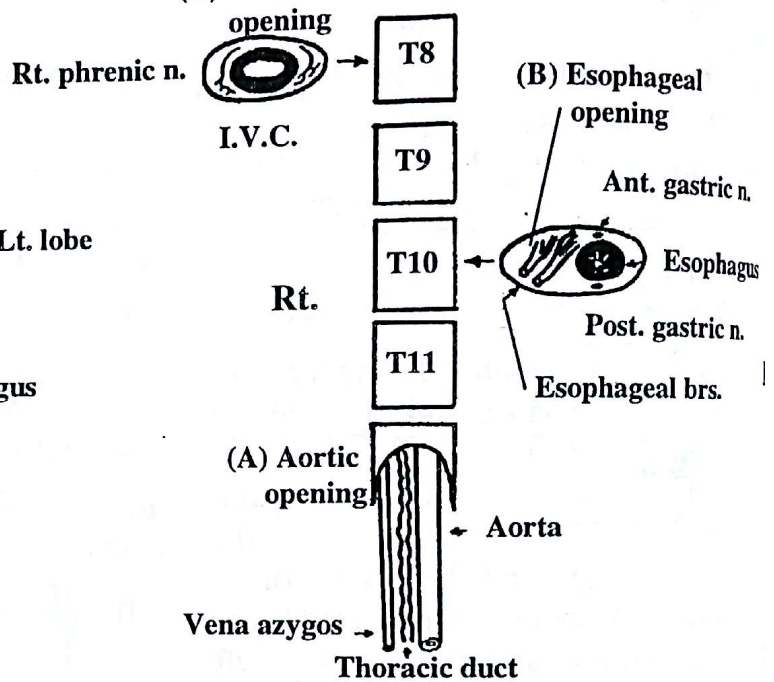
Level: lower border of the last thoracic vertebra. ^{T₁₂}

Position: nearly in the median plane. It is bounded by the median arcuate ligament and the lower border of the last thoracic vertebra.

Structures passing through it: descending aorta, thoracic duct and vena azygos.



(C) Vena caval opening



B. Esophageal opening:

Level: tenth thoracic vertebra. ^{T₁₀}

Position: about one inch to the left of the median plane, within fleshy fibers of the right crus.

These fleshy fibers have a sphincteric action on the lower end of esophagus.

Structures passing through it: esophagus, vagi (anterior and posterior gastric nerves), and anastomotic arteries between the esophageal branches of the left gastric artery and the aortic esophageal arteries: and their accompanying veins.

C. Vena caval opening:

Level: eighth thoracic vertebra. ^{T₈}

Position: about one inch to the right of the median plane, within the central tendon.

Structures passing through it: ^① inferior vena cava, branches of the ^② right phrenic nerve, and some lymph vessels from the liver to lymph nodes in the thorax.

Other structures passing in relation to the diaphragm

1. **Superior epigastric artery:** between the sternal and costal origin to reach the rectus sheath.

2. **Musculo-phrenic artery:** between the slips from seventh and eighth costal cartilages to supply the diaphragm and anterior abdominal wall.

3. **Lower five intercostal nerves:** each passes between two slips of the costal origin to reach the anterior abdominal wall.

4. **Subcostal vessels and nerve:** behind the lateral arcuate ligament.

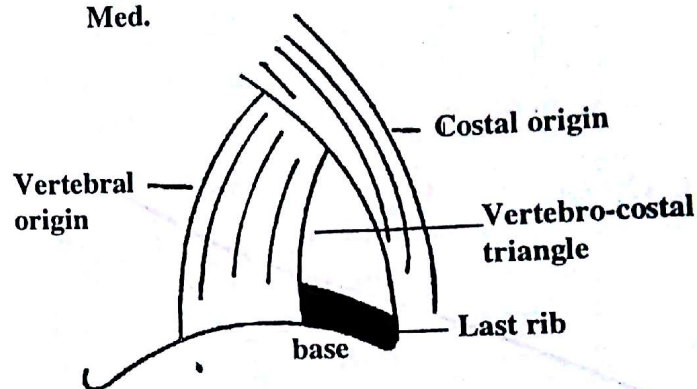
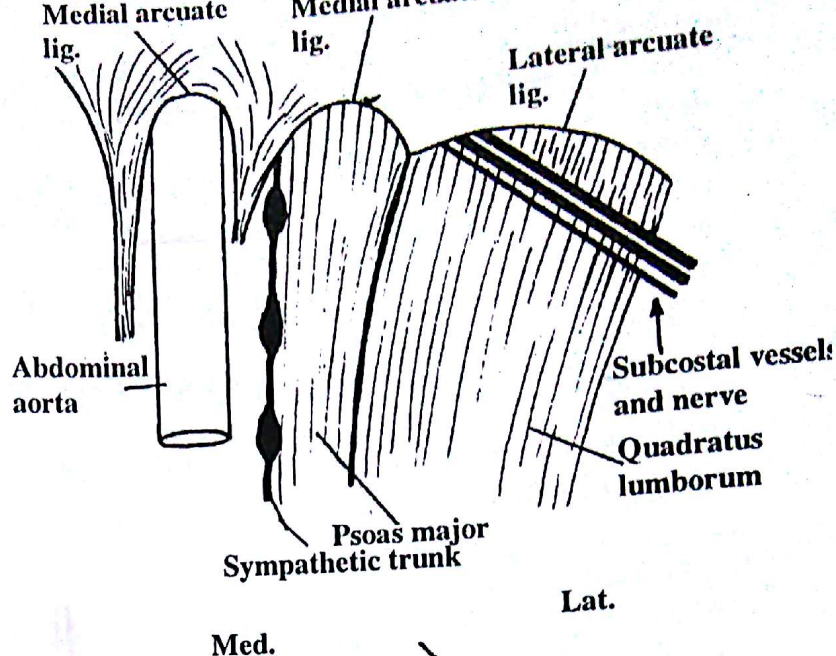
5. **Quadratus lumborum muscles:** reaches its insertion into the last rib by passing behind the lateral arcuate ligament.

6. **Sympathetic trunk:** behind the medial arcuate ligament.

7. **Psoas major muscle:** behind the medial arcuate ligament.

8. **Splanchnic nerves:** piercing the corresponding crus of diaphragm.

9. **Hemiazygos vein:** piercing the left crus of diaphragm.



Vertebro-costal triangle: a triangular gap between the costal and vertebral origins of the diaphragm.

- The base of this triangular gap is the lateral part of the last rib.
- This gap lies behind the kidney: it is filled by fat and areolar tissue which separate the kidney from the pleura.
- This triangle represents the site where the pleura and peritoneum were continuous together during development (Pleuro-peritoneal canal).

Remember that:

- The diaphragm receives multiple nerve supply (phrenic n. & lower intercostal ns. & autonomic ns.) because it is developed from several origins (cervical myotomes, septum transversum mesoesophagus and pleuro-peritoneal membrane).
- The phrenic nerve supplies the abdominal (and not the thoracic) surface of the diaphragm due to folding of the embryo.

ABDOMINAL AORTA

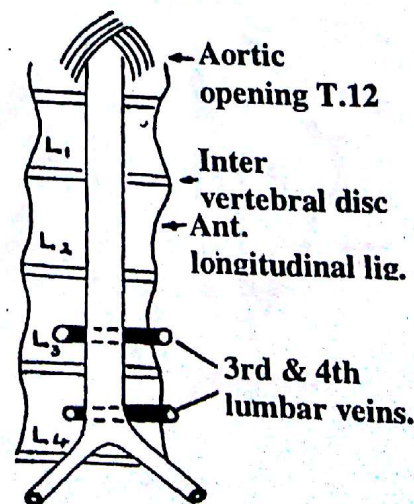
Origin: at the aortic opening of the diaphragm, as the continuation of the descending thoracic aorta.

Course: begins at the lower border of the body of the last thoracic vertebra in the median plane. It descends in front of the vertebral bodies with a slight inclination to the left.

* It ends on the lower part of the 4th lumbar vertebra, slightly to the left of the median plane, by dividing into two terminal branches: the common iliac arteries.

Relations:

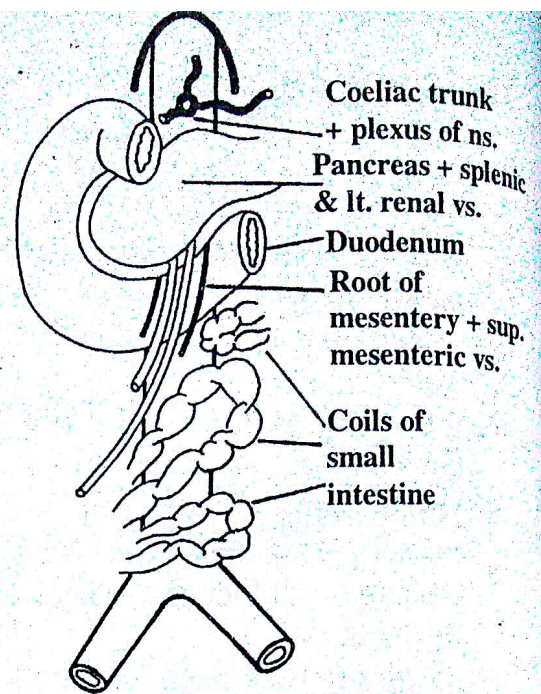
Posteriorly: it is related to the bodies of the upper four lumbar vertebrae, inter vertebral discs & anterior longitudinal ligaments. The 3rd and 4th left lumbar veins cross behind it to reach IVC.



Anteriorly:

The following structures are arranged from above downwards:

- Coeliac trunk and its branches, and the lesser sac, pancreas and splenic vein, left renal vein (behind the head of pancreas).
- Third part of the duodenum, superior mesenteric vessels and root of mesentery.
- Peritoneum of posterior abdominal wall and coils of small intestine.
- It is closely related anteriorly to the coeliac and aortic plexus of nerves.



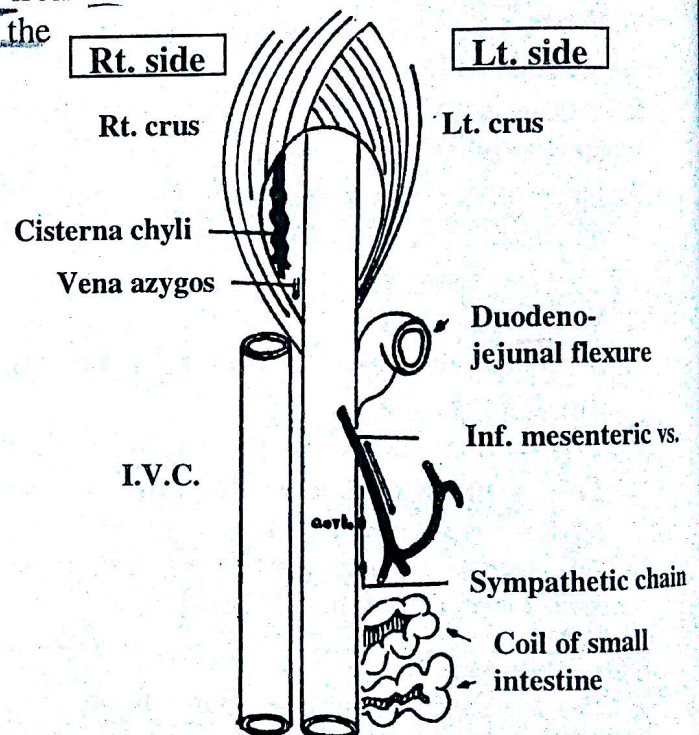
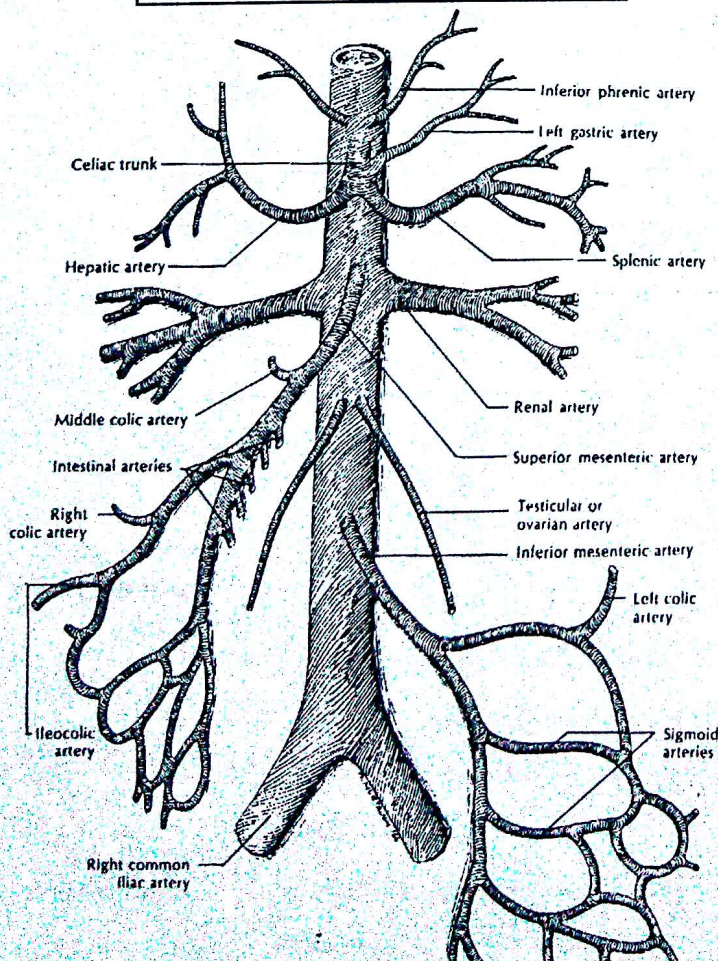
On the right side:

- It is related to the cisterna chyli and thoracic duct, vena azygos, right crus of diaphragm, separating it from the I.V.C. and also to the inferior vena cava below the level of the second lumbar vertebra.

On the left side:

It is related to the left crus of diaphragm, fourth part of the duodenum, duodeno-jejunal flexure, sympathetic trunk, inferior mesenteric vessels, and coils of small intestine.

Branches of abdominal aorta



BRANCHES:

A. Single branches:

1. Coeliac trunk.
2. Superior mesenteric a.
3. Inferior mesenteric a.
4. Median sacral artery.

B. Paired branches:

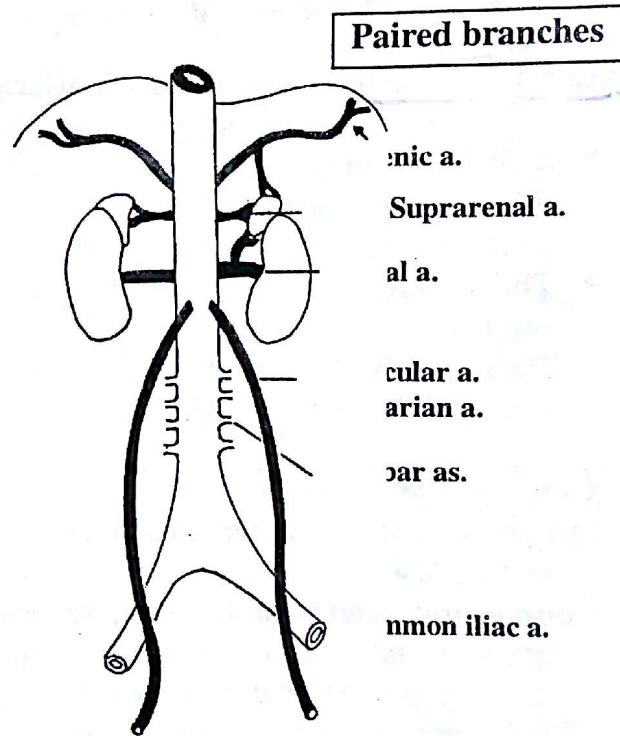
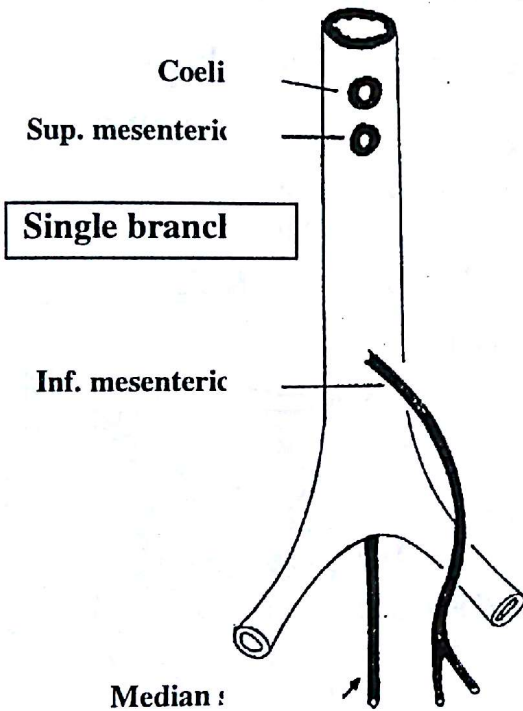
1. Phrenic arteries.
2. Middle suprarenal as.
3. Renal arteries.
4. Testicular or ovarian as.
5. Lumbar arteries.
6. Common iliac arteries.

Level of origin of the single branches:

Branches	Level of origin in relation to the vertebral bodies
1. Coeliac	Upper part of first lumbar vertebra.
2. Superior mesenteric	Lower part of first lumbar vertebra.
3. Inferior mesenteric	Third lumbar vertebra.
4. Median sacral	Fourth lumbar vertebra.

Level of origin of the paired branches:

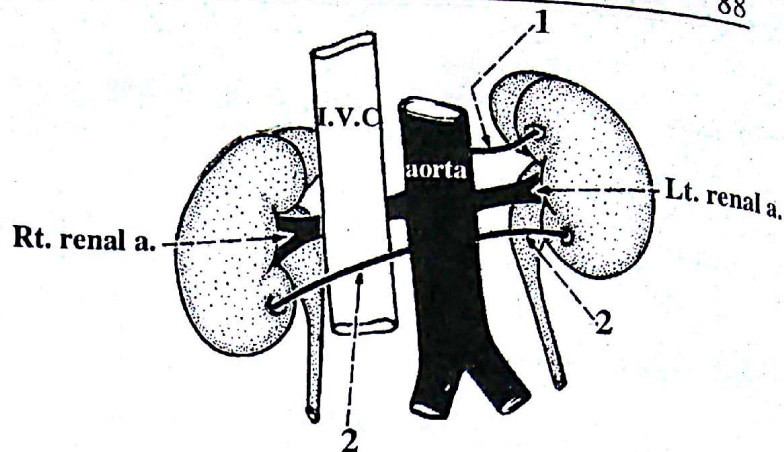
Branches	Level of origin in relation to the vertebral bodies
1. Phrenic	Upper part of first lumbar vertebra.
2. Middle suprarenal	Lower part of first lumbar vertebra.
3. Renal	Second lumbar vertebra.
4. Testicular or ovarian	Third lumbar vertebra.
5. Bifurcation of aorta	Lower part of the fourth lumbar vertebra.



PAIRED BRANCHES OF ABDOMINAL AORTA

- Phrenic arteries:** ramify on the under surface of the diaphragm.
Each artery gives off two or three superior suprarenal arteries to the suprarenal gland of its own side.
- Middle suprarenal arteries:** one on each side of the superior mesenteric artery.
It passes laterally across a crus of the diaphragm and through the coeliac ganglion to reach the suprarenal gland.
- Renal arteries:** large arteries which arise from the sides of the aorta nearly at right angles, and pass laterally in front of the crus the diaphragm and the psoas major muscle to reach the hilum of kidney.
Each artery gives a small inferior suprarenal artery to the suprarenal gland of its own side as well as small twigs to the upper part of the ureter.

- ④ **Accessory renal arteries:** one or two arteries which may be present especially on the left side.
- * They arise from the aorta above (1) or below (2) the renal artery.
 - * The accessory renal artery usually enters the kidney through its upper or lower part and not through the hilum.



- ⑤ **Testicular arteries:** two long and slender arteries which arise from the front abdominal aorta, behind the third part of the duodenum. Each artery passes through the deep inguinal ring into the inguinal canal to supply the testis.

- ⑥ **Ovarian arteries:** correspond to the testicular arteries in male. At the pelvic brim, it passes medially in the suspensory ligament of the ovary, reaching to the broad ligament of the uterus. It passes through the mesovarium where it breaks into branches to supply ovary. It also gives branches to the ureter, uterine tube and a branch which anastomoses with the uterine artery.

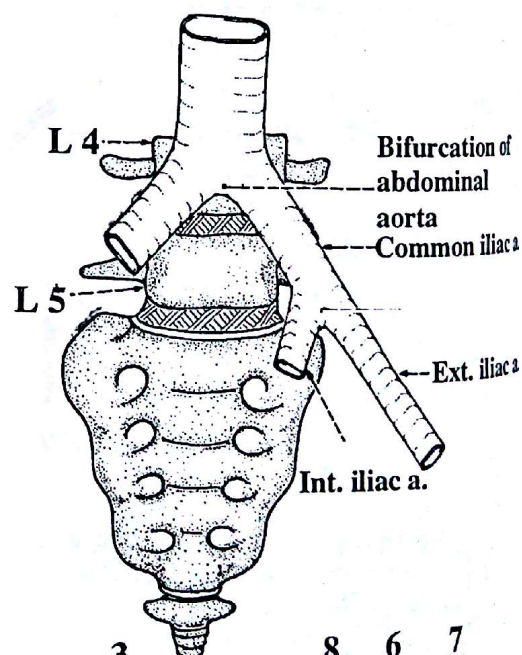
- ⑦ **Lumbar arteries:** four pairs of arteries that arise from the back of the aorta in series with the posterior intercostal arteries.

- * A fifth pair may arise from the median sacral artery.
- Each artery runs laterally and backwards on the body of the corresponding lumbar vertebra, under cover of a tendinous arch in the origin of the psoas major muscle.
- * The arteries of the right side run behind the inferior vena cava.
- They supply the muscles of the posterior abdominal wall, and the muscles and skin of the back.

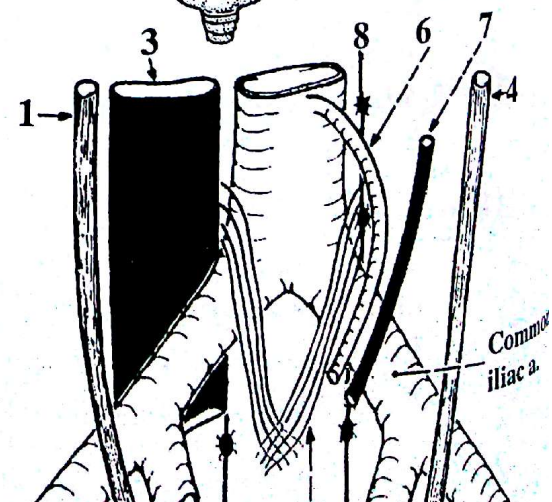
Common iliac arteries

Origin: one of the two terminal branches of the abdominal aorta at L 4.

Course and relations: Each artery runs downwards and laterally and ends opposite the lumbo-sacral disc by dividing into the internal and external iliac arteries.



- The right and left common iliac arteries are covered anteriorly by peritoneum.
- Each common iliac artery is related medially to its common iliac vein and laterally to the psoas major muscle.



- * The right common iliac artery is related anteriorly to the ureter (1) & sympathetic fibers. And is related posteriorly to vertebral column, the sympathetic trunk (2) and beginning of I.V.C (3).
- * The left artery is related anteriorly to the ureter (4), sympathetic fibers (5), and inferior mesenteric artery (6), vein (7). And is related posteriorly to vertebral column and to the sympathetic trunk (8).

Branches: In addition to its two terminal branches each common iliac artery give twigs to the ureter and psoas major.

External iliac arteries

Origin: the larger of the two terminal branches of the common iliac artery.

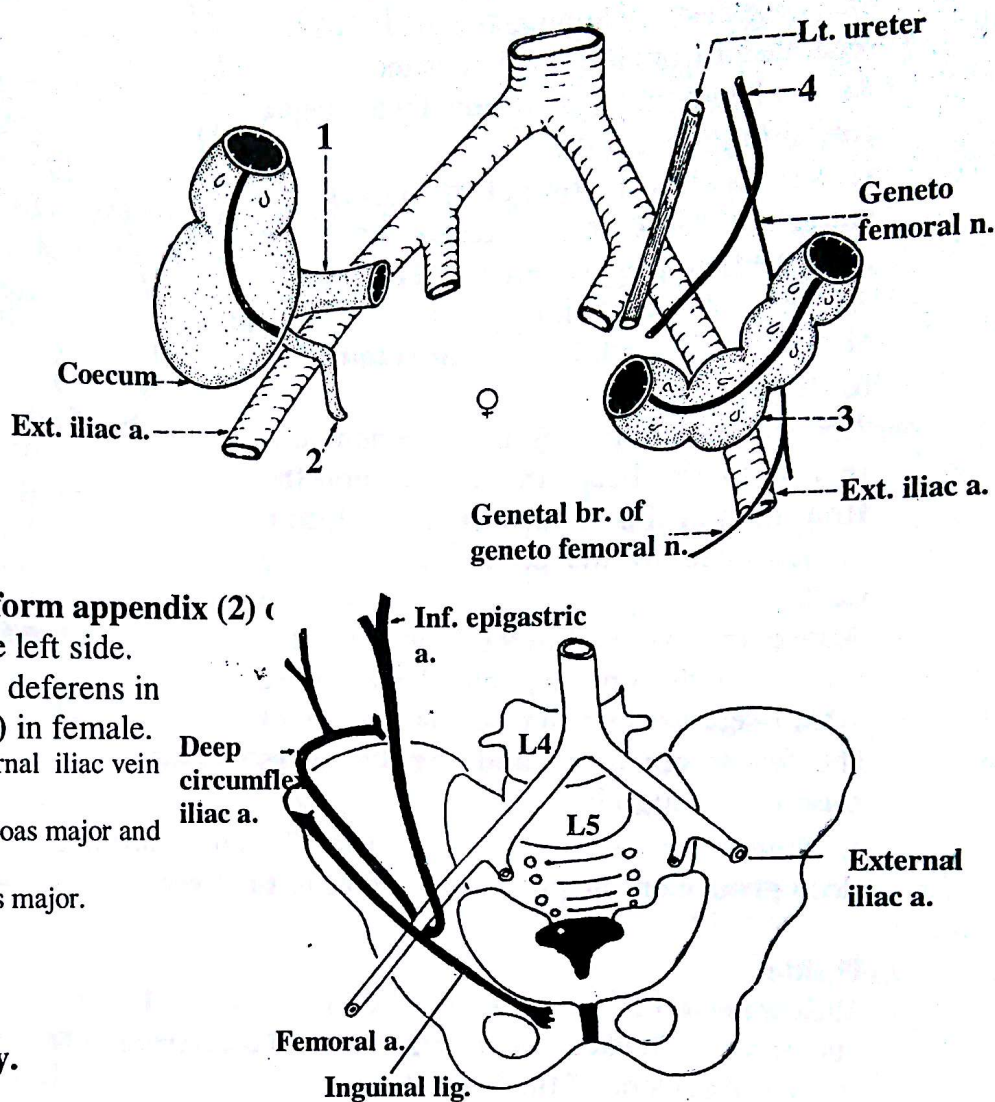
Course and relations: It begins from the bifurcation of the common iliac artery and ends at the mid-inguinal point where it continues as the femoral artery.

Anteriorly and medially, it is covered by peritoneum; and **terminal part of ileum (1)** and **vermiform appendix (2)** (3) and small intestine on the left side.

It is also crossed by the **vas deferens** in male and **ovarian vessels (4)** in female. **Medially,** it related to the external iliac vein below.

Posteriorly, it is related to the **psoas major** and external iliac vein above.

Laterally, it is related to the **psoas major**.



Branches:

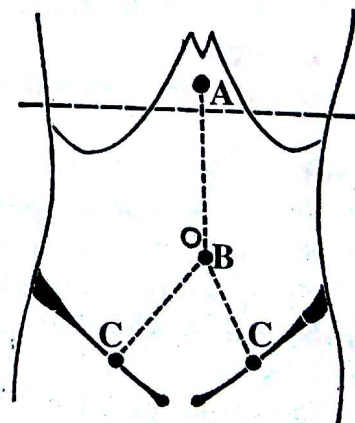
1. **Inferior epigastric artery.**
2. **Deep circumflex iliac artery.**
3. **Twigs to the psoas major.**

Surface anatomy of abdominal aorta and common iliac arteries

* **The aorta** is represented on the surface by a vertical line extending from a point placed in the median plane 1 inch above the transpyloric plane (**point A**) down to a point placed 0.5 inch below and to the left of the umbilicus (**point B**).

* **The common iliac artery** is represented by the proximal 1/3 of a line drawn from point (**B**) to the midinguinal point (**point C**); the distal 2/3 of this line represents the external iliac artery.

N.B: Point (**B**) representing the lower end of the aorta lies opposite the 4th lumbar vertebra which is on the level of the supra-cristal plane (the plane extending transversely between the highest points of the iliac crests on both sides).



INTERIOR VENA CAVA

Origin by the union of the two common iliac veins at the level of the fifth lumbar vertebra, slightly to the right of the median plane.

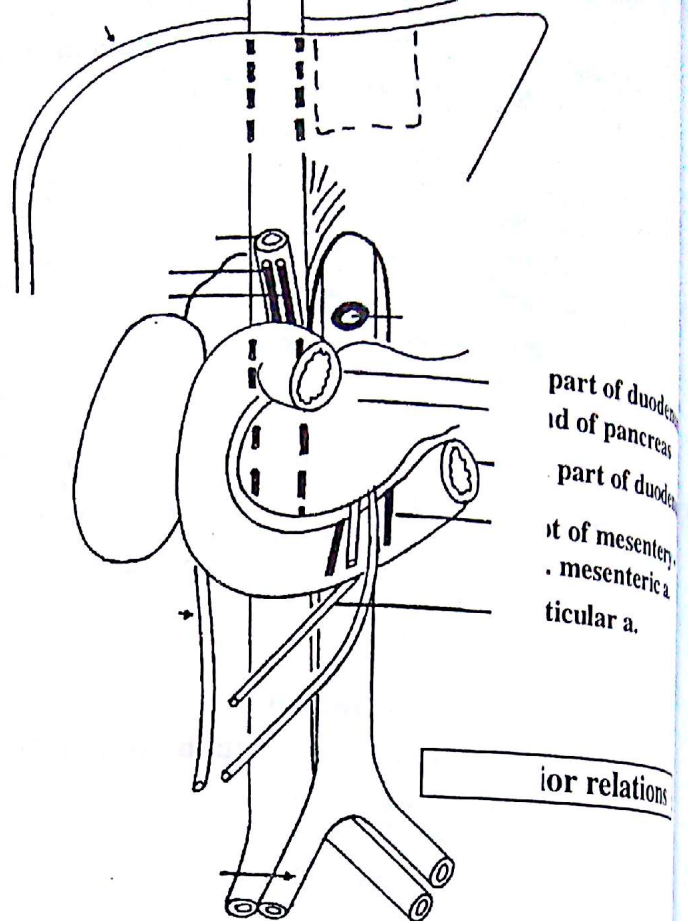
Course: from its origin it ascends in front of the vertebral column and pierces the central tendon of the diaphragm (at T8) to end in the right atrium.

L5

Relations of inferior vena cava:

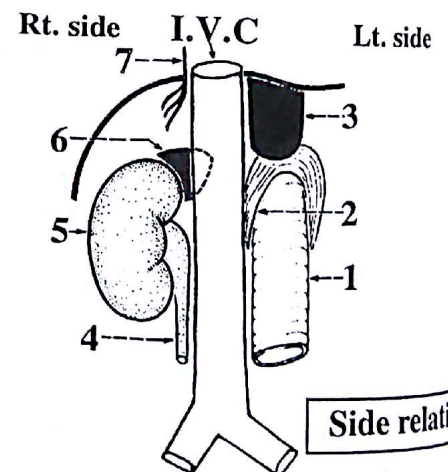
Anteriorly:

- Its lower part is covered by peritoneum of the posterior abdominal wall which separates it from the small intestine.
- At its beginning it is covered by the **right common iliac artery**.
- It is crossed by the **root of the mesentery, superior mesenteric vessels and the right testicular or ovarian artery**.
- At the level of the third lumbar vertebra it is crossed by the **third part of the duodenum**. Rt. ki
- Above the third part of the duodenum, it is related to the **head of pancreas and the first part of the duodenum** from which it is separated by the portal vein and bile duct.
- Above the first part of the duodenum, it is related to the opening into the lesser sac which separates it from the **free margin of the lesser omentum and the structures passing through it**.
- Its upper part is related to: the liver. This part runs in a deep groove on the **posterior surface of the liver**.



Left side:

- Its lower part is related to: the **abdominal aorta (1)**.
- Its upper is related to: the **right crus of diaphragm (2)** and **caudate lobe of the liver (3)**.

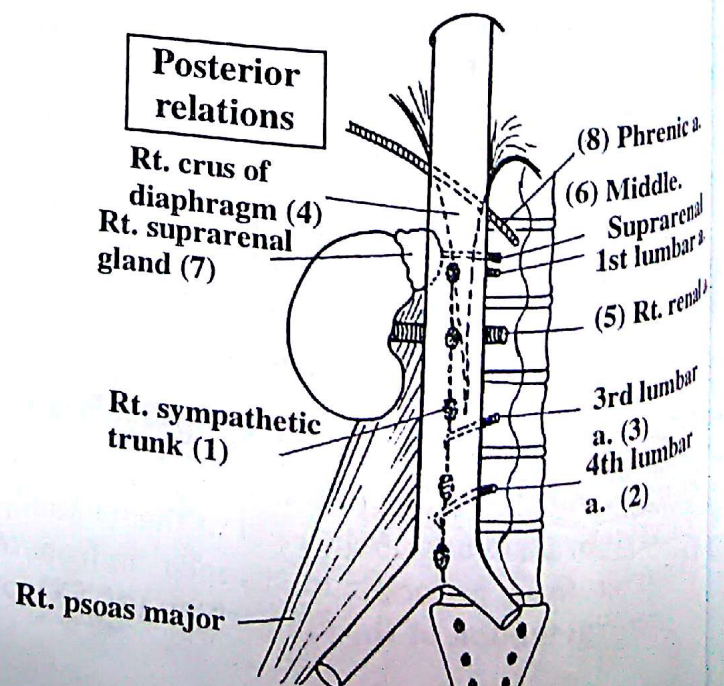


Right side:

- Its lower part is related to: the **right ureter (4)**, medial border of **right kidney (5)** and **suprarenal gland (6)**.
- Its upper part: is related to the **right lobe of the liver (7)** and the **right phrenic nerve (8)**.

Posteriorly:

- Its lower part is related to: the **vertebral column, anterior longitudinal ligament, right sympathetic trunk (1)** and the **fourth (2) and third (3) lumbar arteries**.
- Its upper part is related to the **right crus of diaphragm (4)**, **right renal artery (5)**, **right middle suprarenal artery (6)**, **right suprarenal gland (7)**, **right coeliac ganglion** and **right phrenic artery (8)**.

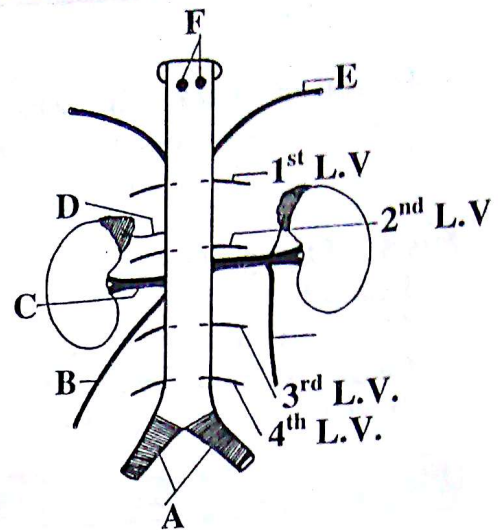


Tributaries of inferior vena cava:

It receives the following tributaries:

1. Right and left **common iliac veins** (A).
2. **Lumbar veins** of both sides.
3. **Right testicular (or ovarian) vein** (B).
4. **Right and left renal veins** (C).
5. **Right suprarenal vein** (D) and
6. **Right and left phrenic veins (inferior phrenic veins)** (E).

* All tributaries of I.V.C are bilateral except the testicular of ovarian (from right side), suprarenal (from right side).

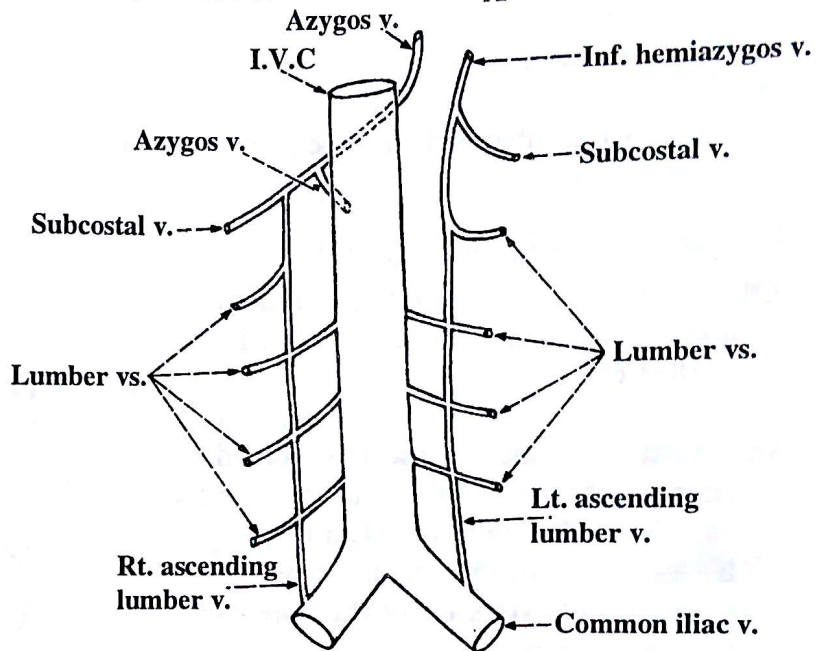


Lumbar veins

These are 4 veins on each side, which end in the inferior vena cava.

* N.B: The lower 3 lumbar veins usually end in the inferior vena cava while the 1st lumbar vein usually joins the ascending lumbar vein.

- The lumbar veins on each side are usually connected by a longitudinal vein called the **ascending lumbar vein**.
- The ascending lumbar vein ascends in front of the transverse processes of the lumbar vertebrae, one on each side.
- It connects the lumbar veins together and ends by joining the subcostal vein to form the azygos vein on the right side and the inferior hemiazygos on the left side.



POSTERIOR ABDOMINAL WALL

Lumbar fascia

(Thoraco-lumbar fascia)

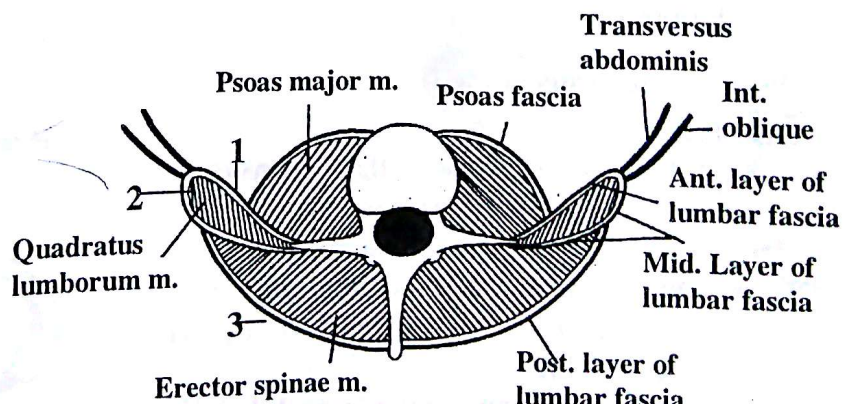


This is strong sheet of deep fascia which binds the deep muscles of the back to the sides of the vertebral column.

It is called lumbar fascia because it is well developed in the lumbar region; but it extends upwards to the neck and downwards to the sacrum.

In the lumbar region it is divided into anterior (1), middle (2) and posterior (3) layers:

- **Anterior layer (1):** covers the anterior surface of the quadratus lumborum.
- **Middle layer (2):** covers the back of the quadratus lumborum and separates it from the sacrospinalis (erector spinae) muscle.



- **Posterior layer (3):** which is the strongest layer covers the erector spinae (sacrospinalis) muscle and extends above on the back of the thorax and below on the back of the sacrum.

Fascia of the psoas and iliacus

This is the layer of fascia which covers the anterior surface of these muscles.

- **Above the iliac crest** it covers the psoas major only.
- **Below the iliac crest** the fascia covers both the psoas iliacus muscles; and is called the fascia iliaca.

Muscles of the posterior abdominal wall:

These are: psoas major (1),
Quadratus lumborum (2) and
Iliacus (3).

- * A psoas minor muscle may be present in front of the psoas major.

Quadratus lumborum muscle

Origin: from the ilio-lumbar ligament and the adjoining part of the inner lip of iliac crest.

Insertion: The muscle ascends behind the lateral arcuate ligament to be inserted into the medial half of the last rib. It is also attached to the tips of the transverse processes of the upper four lumbar vertebrae.

Nerve supply: subcostal nerve and ventral rami of the upper three lumbar nerves.

Action:

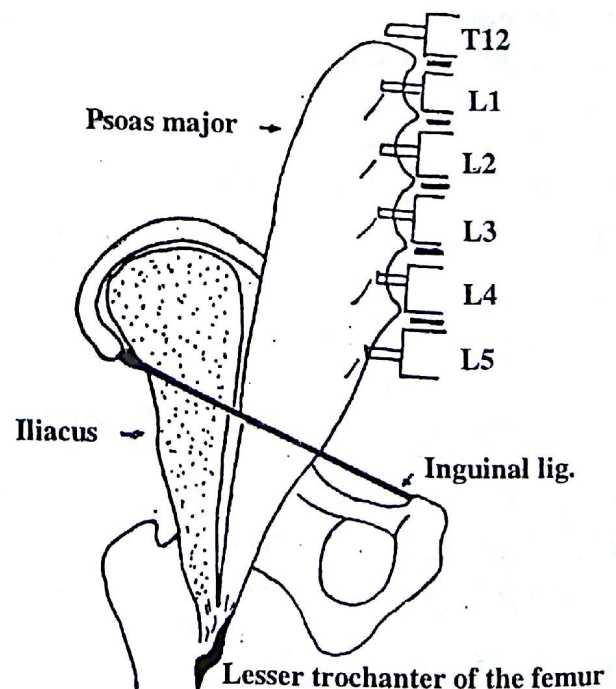
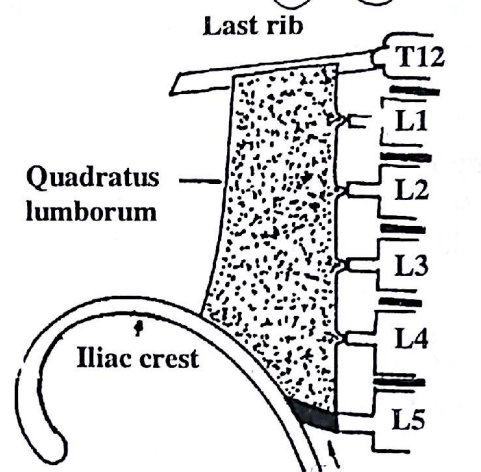
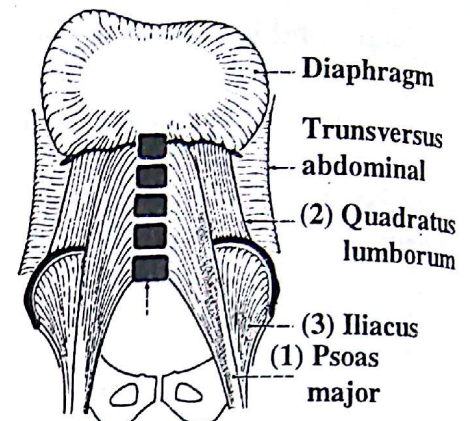
- Lateral flexion of the vertebral column.
- Acting together, both muscles extend the lumbar part of the vertebral column.
- Acts as a muscle of inspiration by fixing the last rib during contraction of the diaphragm.

Psoas major muscle

Origin:

- By five slips: from the transverse processes of the lumbar vertebrae.
- By five slips: each from the bodies of two vertebrae and the intervening disc, beginning from the lower part of the last thoracic vertebra.
- From the tendinous arches which bridge over the lumbar vessels on the sides of the lumbar vertebrae.

Insertion: The muscle descends along the pelvic brim and passes into the thigh



behind the inguinal ligament. Its tendon receives the fibers of the iliacus to be inserted into the lesser trochanter of the femur.

Nerve supply: Ventral rami of the upper three lumbar nerves.

Action:

- Flexion of the thigh, helped by the iliacus.
- Acting from below, the muscles of both sides flex the trunk on the lower limbs.
- Lateral flexion of the vertebral column.

RELATIONS OF PSOAS MAJOR:

*** Anteriorly:**

- Kidney (1) and its renal vessels (uppermost).
- Ureter and renal pelvis (2).
- Gonadal vessels.
- Genitofemoral nerve (A).
- Psoas minor muscle (3) (in 60% of subjects).
- End of the ileum (on the right) and descending colon (on the left).
- Inguinal ligament (lowermost).

*** Medially:**

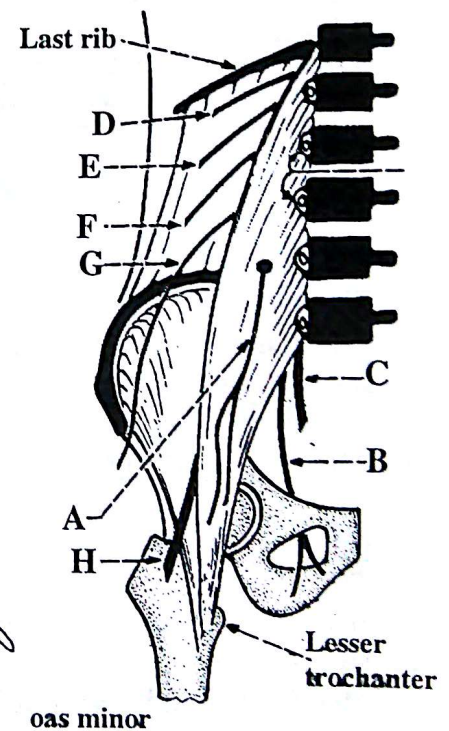
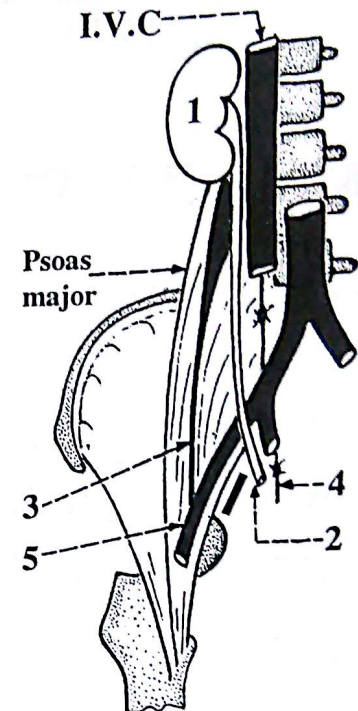
- Sympathetic trunk (4) (along its medial margin).
- External iliac vessels (5) (at the brim of the pelvis).
- 2 nerves: obturator nerve (B) and lumbosacral trunk (C).

*** Laterally:**

- 2 muscles: Quadratus lumborum (above) & Iliacus (below).
- 5 nerves: (from above downwards)
- Subcostal nerve (D), vessels.
- Ilio-hypogastric nerve (E).
- Ilio-inguinal nerve (F).
- Lateral cutaneous nerve of thigh (G).
- Femoral nerve (H) (the lowermost).

*** Posteriorly:**

- Transverse processes of all lumbar vertebrae.
- Superior ramus of the pubis.
- Lumbar plexus (within the posterior part of the muscle).



Psoas minor muscle

This is a small muscle which is present in front of the psoas major in about 60% of people.

Origin: from the adjoining parts of the bodies of the last thoracic and first lumbar vertebrae and the intervening disc.

Insertion: by a long tendon into the pectineal line and the ilio pectineal eminence.

Nerve supply: ventral ramus of the 1st lumbar n.

Action: a weak flexor of the vertebral column in the lumbar region.



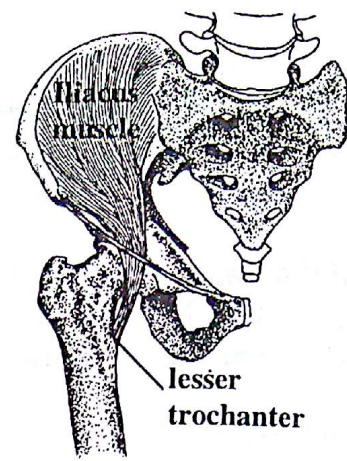
Iliacus muscle

Origin: upper two-thirds of the iliac fossa.

Insertion: with the psoas tendon into the lesser trochanter of the femur.

Nerve supply: femoral nerve in the abdomen.

Action: Acting with the psoas major, it is a flexor of the hip joint.



NERVES ON THE POSTERIOR ABDOMINAL WALL

Lumbar plexus

→ Formations

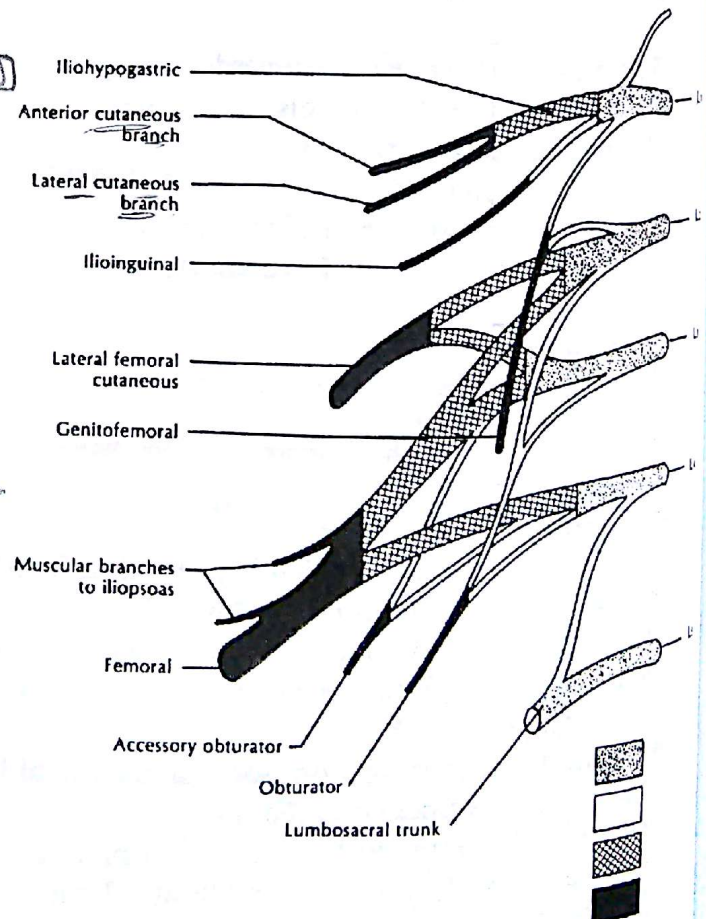
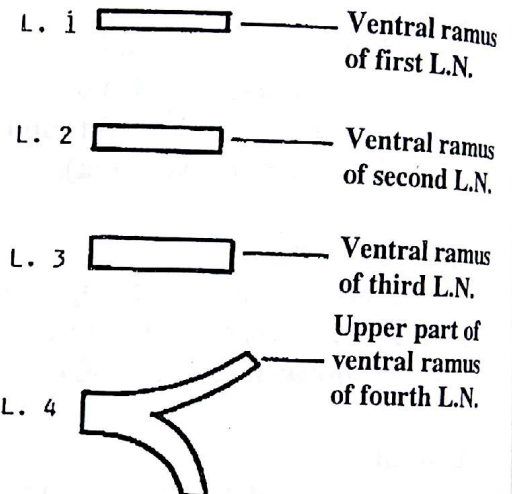
- The lumbar plexus is formed by the ventral rami of the upper three lumbar nerves and the upper part of the ventral ramus of the fourth lumbar nerve.
- The plexus is formed in front of the lower four lumbar transverse processes within the substance of the psoas major muscle.

→ Arrangement of the lumbar plexus:

- * The first lumbar nerve divides into an upper and a lower branches.
- The upper (larger) branch divides into the ilio-hypogastric and ilio-inguinal nerves.
- The lower (smaller) branch unites with a branch of the second lumbar nerve to form the genito-femoral nerve.
- * The remainder of the second nerve, the third nerve and the upper part of the fourth nerve divide into vertebral and dorsal branches.
- The ventral branches of the second, third and fourth nerves unite to form the obturator nerve.
- The dorsal branches of the second third and fourth nerves unite to form the femoral nerve.
- The lateral cutaneous nerve of the thigh arises from the dorsal branches of lumbar 2 and 3.
- The accessory obturator nerve, when present arises from the ventral branches of the third and fourth nerves.

Branches of lumbar plexus

- * The plexus gives muscular branches to the quadratus lumborum psoas major and psoas minor.



* In addition, six named branches spring from the lumbar plexus:

1. Ilio-hypogastric nerve L. 1,
2. Ilio-inguinal nerve L. 1,
3. Genito-femoral nerve L. 1,2

4. Lateral cut. n. of the thigh L. 2,3
5. Obturator nerve L. 2,3,4
6. Femoral nerve L. 2,3,4

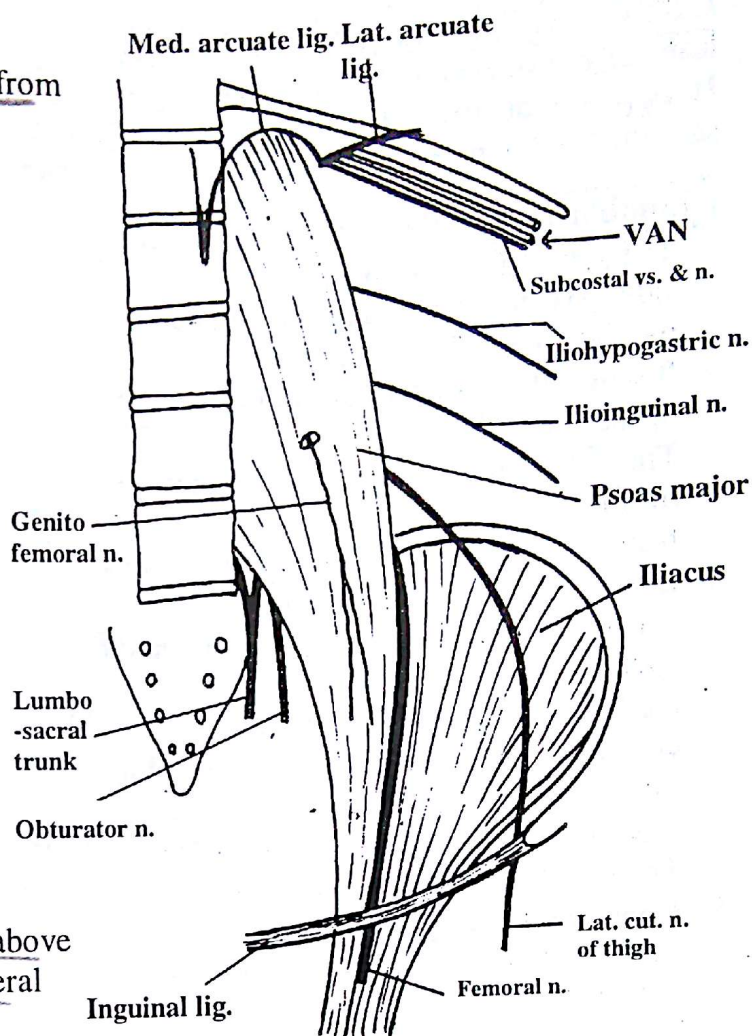
These nerves are formed within the substance of the psoas major.

* The genito-femoral nerve emerges through the anterior surface of the psoas major.

* The obturator nerve emerges through the medial border of the psoas major; at the posterior part of the pelvic brim.

* The ilio-hypogastric, ilio-inguinal, lateral cut. n. of the thigh and

femoral nerves arranged from above downwards emerge through the lateral border of the psoas major.



Some details about the branches of lumbar plexus:

- The ilio-hypogastric and ilio-inguinal nerves are already described.

Genito-femoral nerve (L. 1, 2) emerges on the anterior surface of the psoas, and divides into genital and femoral branches.

The genital branch passes into the deep inguinal ring to supply the cremaster muscle. The femoral branch passes behind the inguinal ligament into the thigh to supply the skin over the upper part of the femoral triangle.

Lateral cutaneous nerve of the thigh (L.2, 3) emerges from the lateral border of the psoas and crosses the iliacus obliquely, running towards anterior superior iliac spine. It passes behind the lateral end of the inguinal ligament close to the anterior superior iliac spine into thigh.

Obturator nerve (L.2, 3, 4) descends through the substance of the psoas major and emerges from the medial border of the muscle at the pelvic brim.

It passes on the side wall of the pelvis and then into the obturator canal to the thigh.

Accessory obturator nerve (L.3, 4) present in 29% of people.

It passes along the medial border of the psoas and then crosses the superior pubic ramus deep to the pectineus where it divides into a number of branches.

One of these branches supplies the pectineus, the other supplies the hip joint.

Femoral nerve (L. 2,3,4) descends through the substance of the psoas and emerges at the lower part of its lateral border.

It descends in the groove between the psoas and iliacus.

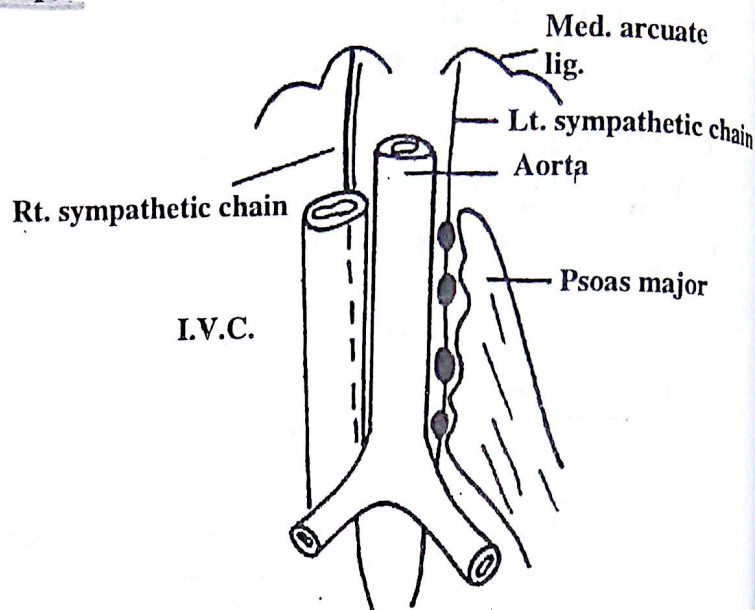
The nerve then descends into the thigh behind the inguinal ligament lateral to the femoral artery and outside the femoral sheath.

In the abdomen it gives small branches to the iliacus.

Lumbo-sacral trunk (L. 4,5) is formed by the union of the lower part of the fourth lumbar nerve with the ventral ramus of the fifth lumbar nerve. It appears at the medial border of the psoas and descends over the ala of the sacrum into the pelvis to take part in the sacral plexus.

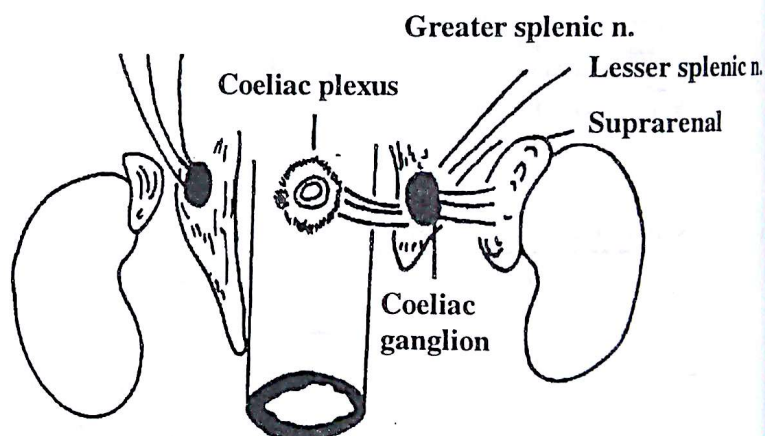
Lumbar part of the sympathetic trunk

- The sympathetic trunks, one on each side, pass to the abdomen behind the medial arcuate ligament.
- It descends along the medial margin of the psoas major.
- The left trunk descends on the left side of the descending aorta; while the right trunk is covered by the inferior vena cava.
- There are usually four lumbar ganglia on each trunk.
- Each ganglion gives a grey ramus communicates to the corresponding lumbar nerve.
- The upper two receive white rami communicantes from L. 1 and 2.
- They also give twigs to the aortic and hypogastric plexuses.



? Coeliac plexus

- This is a plexus of nerves around the coeliac trunk.
- The plexus ends laterally in a number of nodules which collectively form the **coeliac ganglion**, one on each side.
- **The right coeliac ganglion is covered by the inferior vena cava.**
- The left coeliac ganglion is covered by peritoneum of the posterior wall of the lesser sac.



Each ganglion receives the greater and lesser splanchnic nerves which arise from the sympathetic trunk in the thorax.

The nerves when arise from the ganglia form the coeliac plexus of nerves.

Each ganglion, also, gives a great number of branches to the corresponding suprarenal gland.

The coeliac plexus also receives branches from the posterior gastric nerve which carry fibers of both vagi to the plexus.

? Aortic plexus

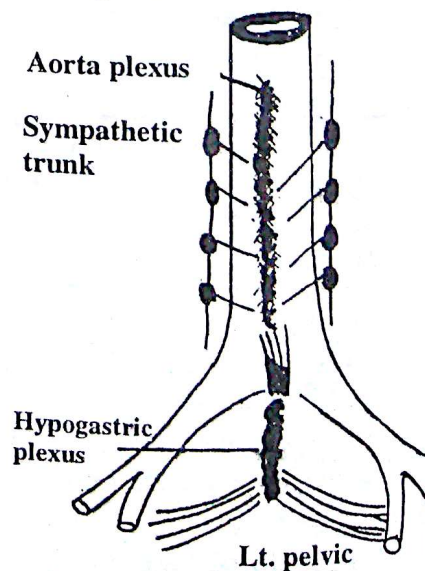
This is a plexus of nerves on the front and sides of the abdominal aorta. It is continuous below with the hypogastric plexus.

? Hypogastric plexus (Presacral nerve)

This is a plexus of nerves which lies below the bifurcation of the abdominal aorta between the two common iliac arteries. It is continuous above with the aortic plexus. Below, it divides into the right and left pelvic plexuses which surround the internal iliac arteries.

? Secondary plexuses

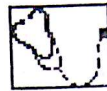
The coeliac and aortic plexuses send secondary nerve plexuses which accompany the branches of the abdominal aorta to their final distribution. These secondary plexuses carry the same names of the accompanying artery.



Applied anatomy of the anterior abdominal wall



Hernia



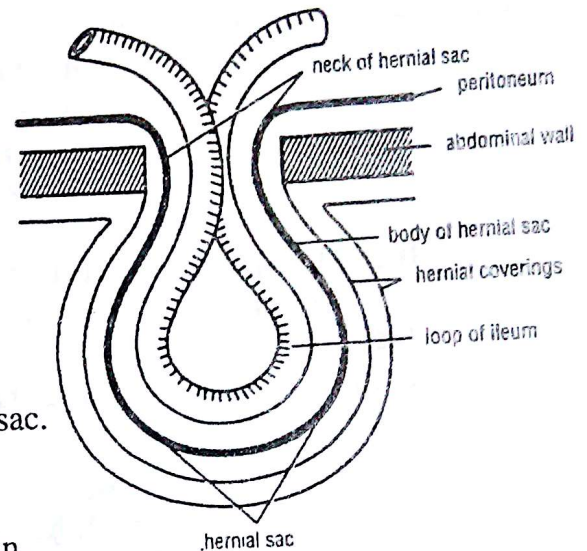
Definition: It is an abnormal protrusion of any abdominal viscus (commonly a loop of the small intestine or a part of the greater omentum) through a weak part of the abdominal wall.

Cause: For the hernia to occur, 2 conditions should exist:

1. Presence of a **defect** in the abdominal wall (weak part or unobliterated fetal duct).
2. **Increased intra-abdominal pressure:** as in chronic cough, chronic constipation or lifting a heavy object.

Structure of the hernia:

1. **Sac** of parietal peritoneum which is pushed by the protruding viscus.
2. **Neck:** the narrow proximal part of the sac (the site where the sac communicates with the peritoneal cavity).
3. **Coverings:** are the structures of the abdominal wall which are pushed by the hernial sac.
4. **Contents:** the protruded abdominal viscus inside the sac.



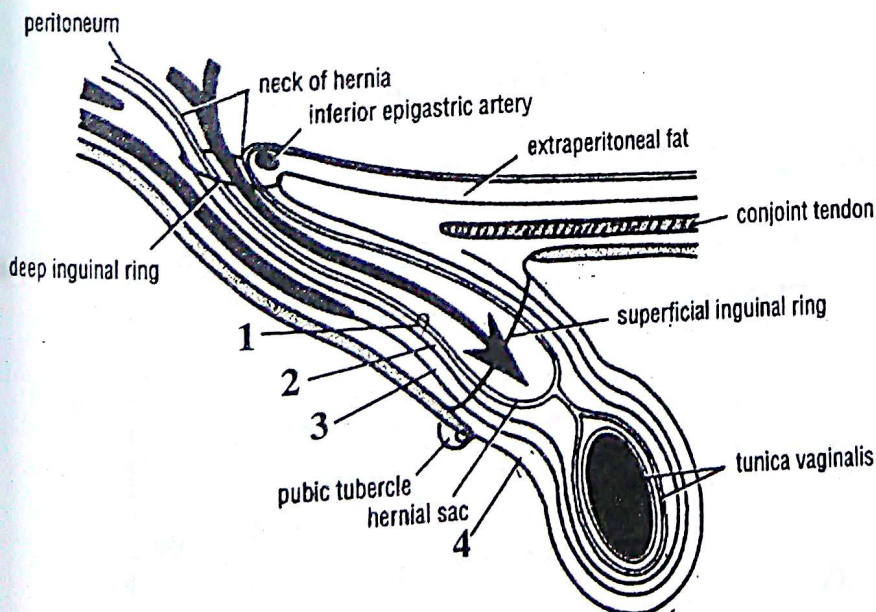
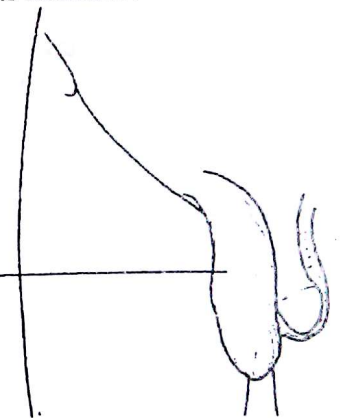
→ Inguinal hernias

- These are the hernias in relation to the inguinal region.
- They are classified into 2 types: oblique (indirect) and direct inguinal hernias.

Oblique (indirect) inguinal hernia

- The Hernia protrudes through the deep inguinal ring into the inguinal canal.
- If it enlarges more it passes out of the superficial ring into the scrotum.

The hernia reached the scrotum



The oblique inguinal hernia has the following coverings:

1. Extraperitoneal fatty tissue.
2. Internal Spermatic Fascia.
3. Cremaster muscle and fascia.
4. External spermatic fascia.
5. Two layers of superficial fascia.
6. Skin.

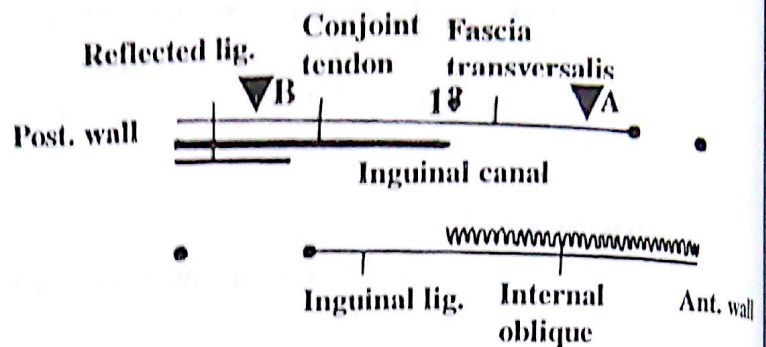
Direct inguinal hernia

The hernia bulges out through the floor of the inguinal triangle either lateral or medial to lateral umbilical ligament. It pushes the posterior wall of the inguinal canal and cannot reach the scrotum.

If the hernia is lateral (A) to the lateral umbilical ligament (1) it is covered by:

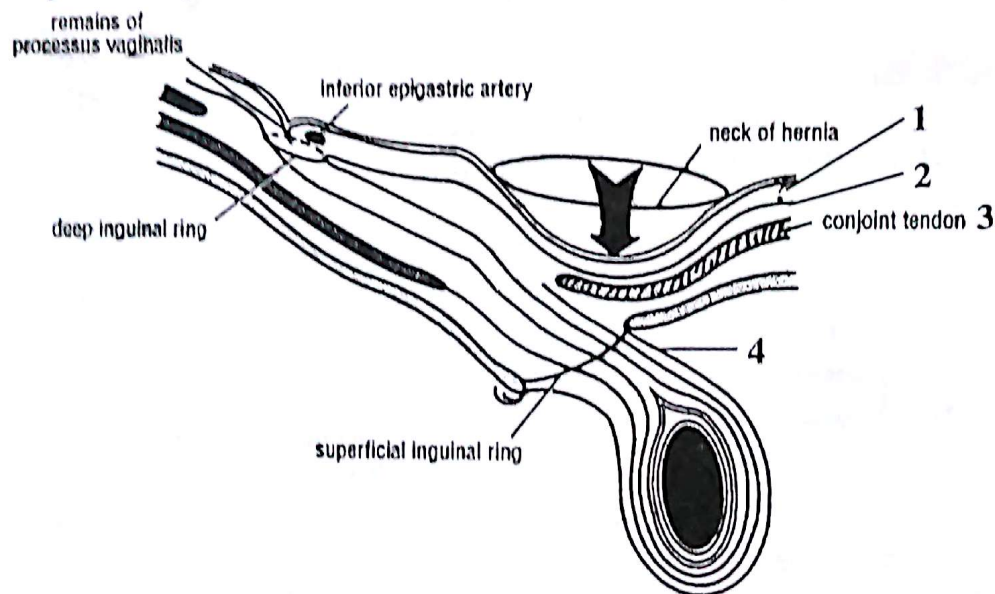
1. Extraperitoneal fatty tissue.
2. Fascia transversalis.
3. Cremaster muscle and fascia.
4. External spermatic fascia.
5. Two layers of superficial fascia.
6. Skin

The hernia above the medial part of inguinal lig. and not reaching the scrotum



If the hernia is medial (B) to the lateral umbilical ligament it is covered by:

1. Extra peritoneal fatty tissue.
2. Fascia transversalis.
3. Conjoint tendon.
4. External Spermatic Fascia.
5. Two layers of superficial fascia.
6. Skin.



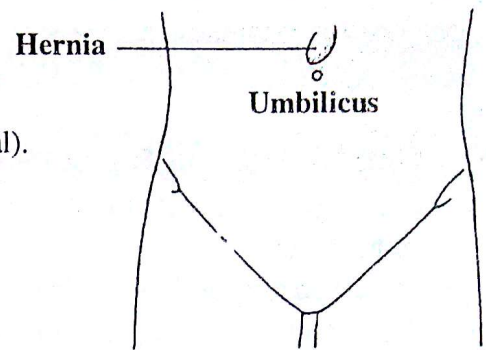
Different between oblique and direct hernia

Oblique (Indirect) Hernia	Direct Hernia
1. Young Age. 2. Usually Unilateral . 3. Can reach the scrotum 4. reduce the Hernia and press on the deep inguinal ring with the thumb. - Ask the patient to cough. Hernia cannot bulge out and its impulse is felt by the thumb. 5. Neck of the Hernia is lateral to the inferior epigastric artery.	1. Old age. 2. Commonly bilateral 3. Cannot reach the scrotum. 4. On doing the same procedure, The hernia bulges out medial to the position of the thumb. 5. neck of the hernia is medial to the inferior epigastric artery.

→ Umbilical Hernia

The hernia bulges out through the umbilical region.
Commonly it occurs in the linea alba just above the umbilicus (para-umbilical).
It is covered by:

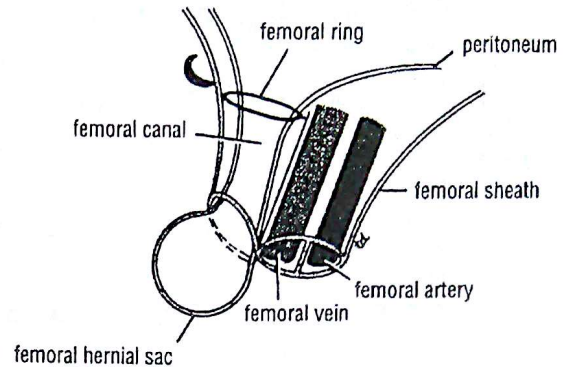
1. Stretched and attenuated linea alba.
2. Superficial fascia.
3. Skin.



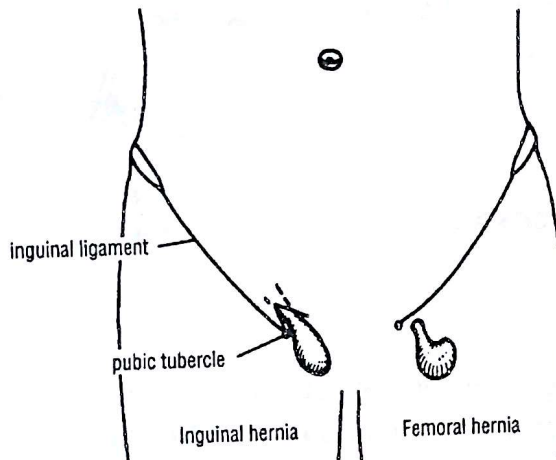
→ Femoral Hernia

The hernia passes through the femoral canal into the thigh.
Then, it bulges forward through the saphenous opening.
It is covered by:

1. Stretched femoral septum.
2. Anterior wall of femoral sheath.
3. Cribriform fascia.
4. Two layers of superficial fascia.
5. Skin.



Differences between inguinal and femoral hernia



Inguinal Hernia	Femoral hernia
1. Hernia bulges above the inguinal ligament.	1. Hernia bulges below the inguinal ligament.
2. Hernia sac is above the pubic tubercle	2. Hernial sac below and lateral to the pubic tubercle.
3. Hernia is more common in males	3. Hernia is more common in females

Mechanism of the inguinal canal:



The presence of the inguinal canal represents a weakness in the lower part of the anterior abdominal wall.

This weakness is compensated by the following mechanism:

1. **The shutter mechanism of the internal oblique muscle.**
On straining the lower arched fibers of the internal oblique contract approximating the roof to the floor like a shutter.
2. **The flap valve mechanism:**
The 2 inguinal rings do not lie opposite each other (due to the obliquity of the canal).
Therefore, when the intra abdominal pressure rises the ant and posterior walls of the canal are approximated thus obliterating the passage.
3. **The ball valve mechanism:**
Contraction of the cremasteric muscle helps the spermatic cord to plug the superficial inguinal ring.
4. **The slit valve mechanism:**
Contraction of the external oblique muscle approximates the 2 crura of the superficial ring thus narrowing it to a slit.
The intercrural fibers prevents the separation of the 2 crura.
5. **The superficial ring is guarded from behind** by the conjoint tendon and the reflected ligament.
6. **The deep ring is guarded anteriorly** by the fleshy fibers of the int. oblique muscle.
All narrow mechanisms help to narrow the canal and its opening during increased intra abdominal pressure thus prevent the herniation of the abdominal viscera.

Applied anatomy of peritoneum

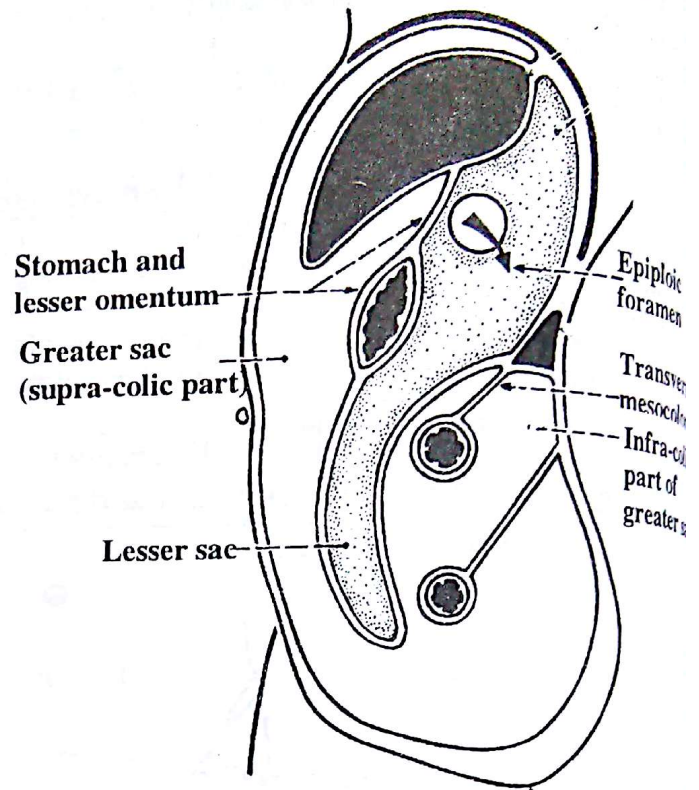


Subdivisions of the peritoneal cavity

- The general peritoneal cavity is divided into 2 sacs:
 1. Greater sac.
 2. Lesser sac.
- The 2 communicate together at the **epiploic foramen** (opening into lesser sac).

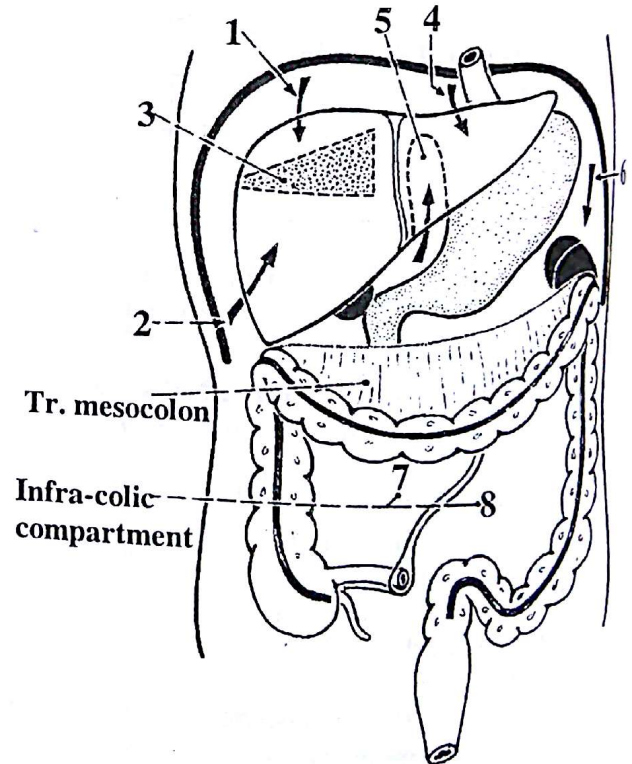
1. Greater sac of peritoneum:

- It is the part of the peritoneal cavity which is exposed by opening the parietal peritoneum of the anterior abdominal wall.
- It is incompletely divided into 2 compartments (**supra colic & infra colic** compartments) by a partition formed of:
 1. Lesser omentum.
 2. Stomach.
 3. Greater omentum.
 4. Transverse colon and transverse mesocolon.



A. The supra-colic compartment:

- It is the anterosuperior part of the greater sac (lies above & in front of the partition).
- The supra colic compartment extends from the transverse mesocolon below, to the diaphragm above.
- It is divided into Rt. & Lt. parts by the falciform ligament of the liver.
- Each part comprises 3 sub phrenic spaces: one space is extra peritoneal while the other 2 are intra peritoneal. They are named as follows.
 - * To the right of falciform ligament the spaces are: **right subphrenic space (1)**, **right subhepatic space (2)** & **right extra peritoneal space (3)**.
 - * To the left of falciform ligament the spaces are: **left subphrenic space (4)**, **lesser sac (lt. subhepatic space)(5)**, & **lt. extra peritoneal space (6)**.



B. The infra-colic compartment:

- It is the postero inferior part of the greater sac (lies below & behind the partition).
- It is subdivided by the mesentery of the small intestine into **upper Rt. region (7)** & **lower Lt. region (8)**.
- The lower Lt. region communicates freely with the pelvic cavity.

Subphrenic spaces

Definition: they are potential spaces lying below the diaphragm in relation to the liver, the falciform ligament and the abdominal wall.

They may be sites of collection of pus forming a subphrenic abscess.

Classification: the subphrenic spaces include **3 right** and **3 left spaces**:

* The **3 right subphrenic spaces** are: right subphrenic, right sub-hepatic (intra peritoneal spaces) + right extra peritoneal subphrenic space

1. Rt. subphrenic space (1):

- Lies between the Rt. lobe of the liver & the diaphragm on the Rt. side of falciform ligament.
- It is closed posteriorly by the upper layer of coronary ligament and the Rt. triangular ligament.

2. Boundaries:

Anteriorly: inf. surface of Rt. lobe of liver.

Posteriorly: ant. surface of the Rt. kidney.

Superiorly: lower layer of the coronary ligament.

Inferiorly: opens into the general part of peritoneal cavity in the supine position and is the commonest site for subphrenic abscess and accumulation of fluid effusions.

3. Rt. extraperitoneal space (3): between the bare area of the liver and the diaphragm.

It is bounded between the upper and lower layers of the coronary ligament.

* The **3 left subphrenic spaces** are: left subphrenic, left sub-hepatic (intra peritoneal spaces) + left extra peritoneal subphrenic space.

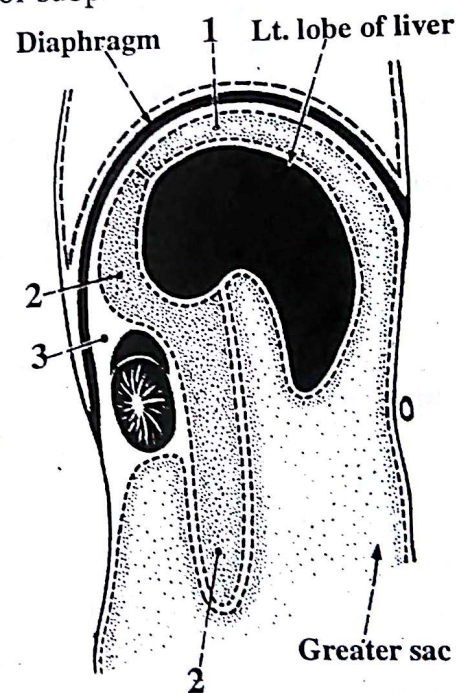
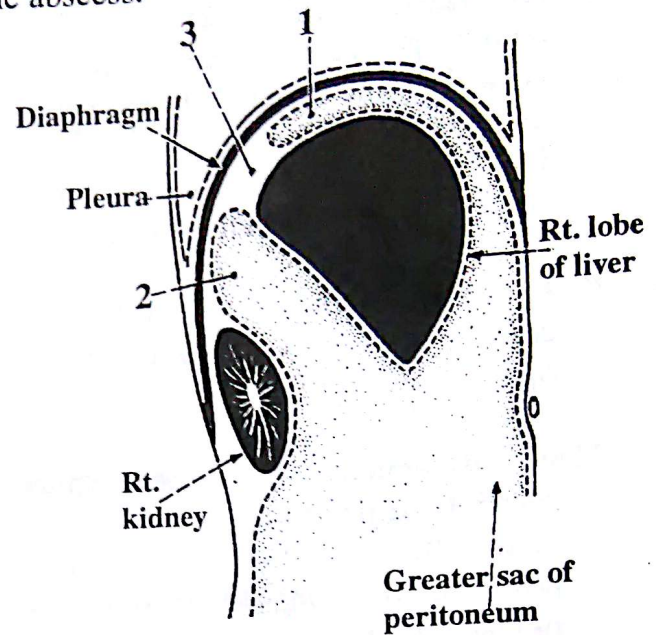
1. Lt. subphrenic space (1):

- Lies between the Lt. lobe of the liver & the diaphragm on the Lt. side of falciform ligament.
- It is closed posteriorly by the Lt. triangular ligament.

2. Lt. sub-hepatic space (lesser sac of peritoneum) (2).

3. Lt. extraperitoneal subphrenic space (3): lies around the Lt. subphrenic gland and the upper pole of the Lt. kidney.

N.B: The Rt. and the Lt. extraperitoneal space are shut off the general peritoneal cavity.



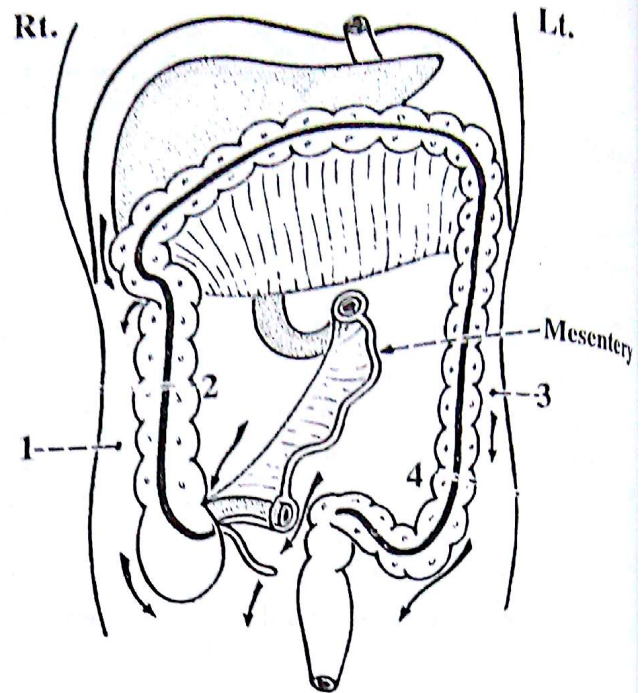
Para-colic gutters

Definition: these are longitudinal grooves lying along side the ascending and descending colons.

They may transmit pus between the different parts of peritoneal cavity in peritonitis.

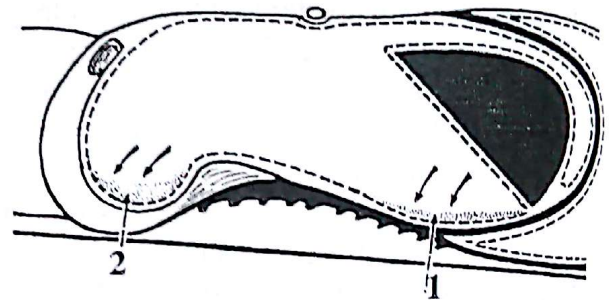
Classification: Para-colic gutters include:

1. **Rt. lateral para-colic gutter (1)** (lateral to ascending colon): it is the only gutter which is open above it communicates with the rt. anterior and posterior subphrenic spaces above and the pelvic cavity below.
2. **Rt. medial gutter (2)** (medial to ascending colon): it is closed both above and below (lies between the root of mesentery and the ascending colon).
3. **Lt. lateral gutter (3)** (lateral to descending colon): it is closed above by the phrenico colic ligament but open below.
4. **Lt. medial gutter (4)** (medial to descending colon): closed above by Lt. colic flexure but open below into the pelvis.



Most dependent peritoneal spaces in the recumbent position

- With the patient in the supine (recumbent) position, the **hepato-renal recess (1)** and the **pelvic cavity (2)** are the lowest areas of the peritoneal cavity.
- Therefore, infected material from ruptured appendix may extend upwards to form subphrenic abscess between the liver and either the diaphragm (subphrenic space) or the right kidney (hepato-renal recess).
- Infection may spread from the peritoneum to the pleura via the diaphragmatic lymphatics.
- The patient with subphrenic abscess often complains of pain over the shoulder.
- This is because the skin of the shoulder is supplied by supraclavicular nerves (C3,4) which have the same segmental origin as the phrenic nerve which supplies the peritoneum in the center of the under surface of the diaphragm.
- When the patient lies in the semi-recumbent position the infected material collect in the pelvis.



Peritoneal recesses

- These are spaces behind the peritoneal folds.
- They are of surgical importance since a piece of intestine may enter into the recess producing internal hernia, and may become constricted (strangulated).
- This constriction (strangulation) of the intestine has to be relieved by cutting the peritoneal fold to pull the intestine out of the recess.
- So, it is necessary to know whether these folds contain blood vessels or not.

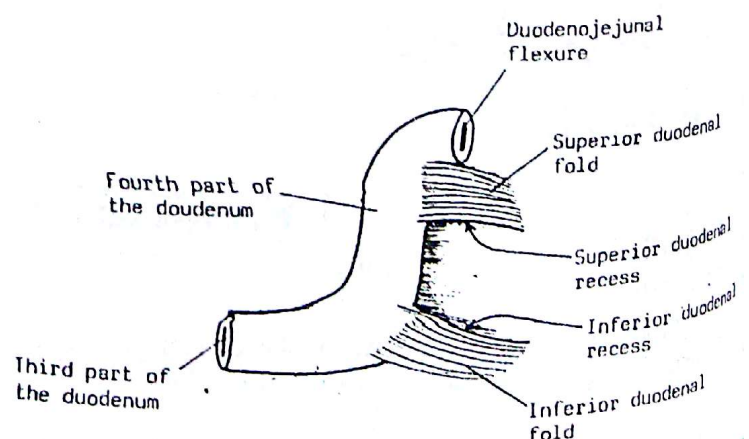
1. Duodenal recesses:

a. Superior duodenal recesses:

- It lies lateral to the 4th part of duodenum.
- It is 2 cm deep.
- Its opening looks downwards.
- It lies behind a non-vascular fold.

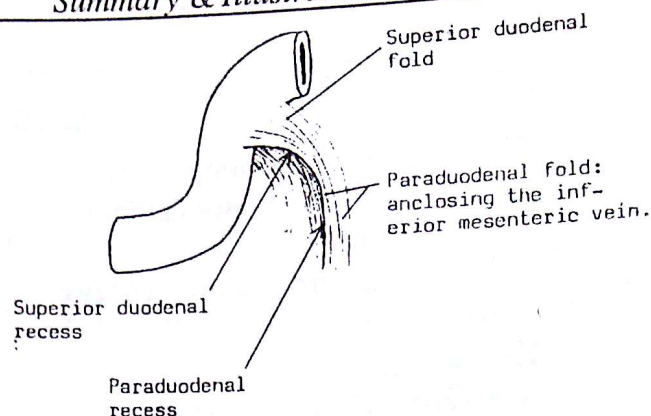
b. Inferior duodenal recess:

- It lies lateral to the 4th part of the duodenum.
- It is 3 cm deep.
- Its opening looks upwards.
- It lies behind a non-vascular fold.



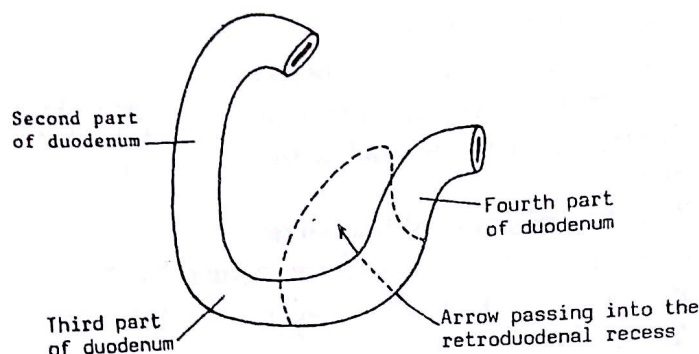
c. Para-duodenal recess:

- It lies lateral to the 4th part of the duodenum.
- Its opening is directed to the right side (medially)
- It lies behind a vascular fold containing inferior mesenteric vein and ascending branch of left colic artery in its free margin.



d. Retro-duodenal recess:

- It lies behind the 3rd and 4th parts of the duodenum.
- It is 8-10 cm deep.
- Its opening is directed downwards.
- It lies in front of the abdominal aorta.



2. Caecal recesses:

a. Superior ilio-caecal recess:

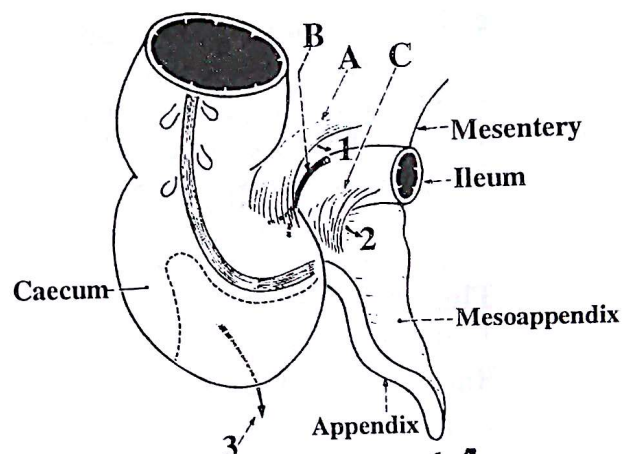
- Boundaries:
 - Anteriorly: vascular fold of caecum (A) (containing anterior caecal artery (B)).
 - Posteriorly: mesentery of ileum.
 - Inferiorly: terminal part of ileum.
- Its opening looks downwards and to the left.

b. Inferior ilio-caecal recess:

- It is bounded anteriorly by the triangular ileo-caecal fold (C) (non-vascular).

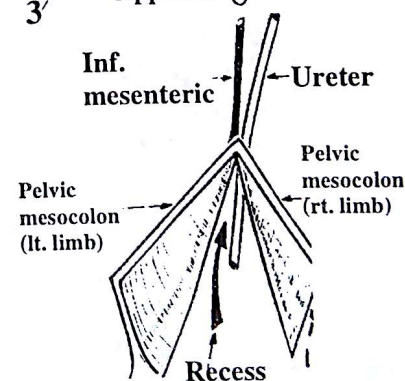
c. Retro-caecal recess:

- It extends upwards behind the caecum.
- Its opening looks downwards.
- It may contain the vermiform appendix.



2. Recess of pelvic mesocolon (intersigmoid recess):

- It extended upwards behind the apex of the pelvic mesocolon.
- Its opening looks downwards.



Umbilical folds

They include 5 peritoneal folds lying in the inner surface of the anterior abdominal wall and converge towards the umbilicus as follows:

1. Median umbilical fold (1): lies in the middle line behind linea alba. It is raised by the median umbilical ligament (obliterated urachus) which extends from the apex of the urinary bladder to the umbilicus.
2. Medial umbilical folds (2) (Rt. & Lt.): lying on each side of midline they are raised by the lateral umbilical ligaments (obliterated umbilical arteries) which extend from the side of the pelvis to the umbilicus.
3. Lateral umbilical folds (3) (Rt. & Lt.): lying lateral to the medial folds. Each fold is raised by an inferior epigastric artery.

